Aging and Retirement

# The Impact of Artificial Intelligence on Retirement Professionals and Retirees: A Collection of Essays

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## A Collection of Essays

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## A Collection of Essays

## Introduction and Acknowledgments

### INTRODUCTION

The Society of Actuaries Aging and Retirement Strategic Research Program Steering Committee issued a call for essays to explore the impact of artificial intelligence (AI) and large language models (LLM) on retirement professionals and retirees. The objective was to gather a variety of perspectives and experiences with AI and LLM in different retirement settings—both now and in the future. It is the goal of this collection to spur thoughts for future research and set the stage for upcoming efforts.

The collection includes four essays that were accepted for publication from all submissions. Two essays were chosen for awards based on their creativity, originality, and promotion of further thought in this area:

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|---|---|
| Award Winner | The Messy Complexity of Real Lives<br>Stefano Orfanos, FSA, Ph.D. |
| Award Winner | The Augmented Actuary and the Empowered Retiree: Navigating the AI Paradigm Shift in Retirement Security<br>Niranjan Rajendran, B. Sc. (Hons) |

### THE CALL FOR ESSAYS

#### BACKGROUND AND PURPOSE

Hardly a day goes by without a feature story about the latest reverberation from the expanding use of Artificial Intelligence/Large Language Models (tools) in a variety of settings. The pace of use (and misuse) of these tools, such as ChatGPT and Bard, has been explosive and shows no sign of abating. Many experts would argue we are on the cusp of a permanent paradigm shift in teaching/academics and overall application of technology.

There is reason to think that it will strongly impact in significant ways the nature and extent of work currently done by actuaries, financial planners, advisors, attorneys and other retirement professionals. Recent technological developments such as advances in quantum computing and others reinforce this impression.

Outside of professional settings, retirees and those nearing retirement themselves could significantly feel the reach of these tools. For example, they may change the method of delivery of investment advice, asset allocation, and general planning. At the same time, though, these tools may create new risks that expose retirees in ways that they have not and could not have been prepared.

With these issues in mind, the Society of Actuaries (SOA) Research Institute's Aging and Retirement program is interested in an exploration of this topic from a variety of perspectives. The result of this effort is intended to

provide a useful resource for readers to become well-grounded on the issues surrounding the impact of these tools in a retirement context and set the stage for future research.

## RESEARCH OBJECTIVE

The sponsors are seeking researchers and essayists to explore the multifaceted impacts of AI/Large Language Model tools on retirement professionals, retirees and those planning for retirement. The desired combined end product of this effort is a resource that will aid in the understanding of relevant issues while providing current considerations and potential future dynamics of AI/Large Language Models in this area.

The intended audience for this effort is actuaries and other retirement professionals such as financial planners.

The following are illustrative of the topics and questions that might be addressed in an essay or research project. Respondents to this RFP/Call for Essays are not required or expected to address all or even any of these topics/questions. Rather they are encouraged to also consider other question(s) or topic(s) they deem critical to the work done by the Society of Actuaries and its members. To maintain a reasonable scope, researchers should be selective in the number of topics/questions they cover.

Responses to this RFP/Call for Essays should clarify the time horizon under consideration in a research project or essay. The SOA Research Institute prefers that researchers address both current and future professional and retiree considerations of the AI/Large Language Model questions or topics they plan to focus on. Respondents are, however, free to cover only one aspect, but in either case, the responses should clarify what will be covered.

Retirees and Those Planning for Retirement

- What are the risks and challenges that these tools may present specifically for the aging community? For example, what are risks to individual investments they may hold?
- What is the best way to educate retirees and those planning for retirement on the uses of these tools?
- What are ways to address fears that these individuals may feel about the adoption and use of such tools? What are concerns that are warranted for these individuals and which may be dispelled with better information?
- What are the ways that these tools can best be used to educate and otherwise support individuals in managing their personal finances during their retirement years?
- How do you make these tools useful for people in retirement if they may end up being the last to use them and the most exposed to abuse by them? How can tool interfaces be improved in this regard? How can their underlying algorithms be improved?
- What may be risks introduced by using tools with algorithms that may be potentially biased or discriminatory? How might such biases, that may be racial, gender or age-based, specifically impact an aging population?
- What are ways to prevent fraud and scams directed at retirees that make use of these tools? What are risks posed by such fraud and how can AI itself be used to help educate individuals on it?
- How might these tools be used to promote better living in retirement? Can they help with more easily living independently, managing bills/payments, monitoring cognitive decline, etc.? Are there ways these tools can provide support to and lessen the adverse consequences associated with memory loss?
- Can these tools help retirees and those planning for retirement better navigate getting help, such as more efficiently reaching customer service centers?

- Can these tools help retirees who wish to work part time in retirement or otherwise return to the workforce?

Retirement Professionals and Retirement Plans

- What are ways that these tools can be used for preparation of actuarial analyses for retirement plans (defined benefit, defined contribution, etc.)? What are the most beneficial uses for such analyses? Which types of analyses may need to be approached with greater caution? For instance, how do you assess whether outputted information is reliable vs inaccurate/fabricated in this context? Can these tools themselves be used to help make such assessments? Which types of analyses are completely inapplicable or in other ways limited? How do the preceding considerations differ between now and in the future?
- How would the issues in the previous bullet apply to retirement professionals who advise on retirement planning and prepare individual projections and other analyses?
- What are uses of these tools for preparing reports that retirement professionals may need to create for any purposes outside of actuarial analyses? How might this impact the current roles and responsibilities of retirement professionals at different career stages? Are there positions that may become obsolete?
- To what extent can these tools be used to professionally manage retirement investments and portfolios? How can these tools be used to help market such services?
- How can prompts be written? What needs to be watched out for?
- How might these tools support plan administration and reduce the need for personalized communication in writing and by phone? How does one avoid a participant getting stuck without an answer?
- How do employers of retirement professionals feel about these tools? Are they embracing the tools for their employees' use or are they steering employees away from them? What discomfort may they have?
- With the widespread and increased knowledge of and use of AI tools, what are approaches on ethical standards, policies, or constraints that professionals or organizations may be or should be adopting for retirement planning uses of the tools?
- How would the differing objectives of pure research vs profit making impact the use of tools for retirement planning purposes?
- What impact would the availability of less expensive and rapidly developed tools (DeepSeek, etc.) have on those interested in using AI for retirement planning purposes?
- What potential does AI have to enhance personalization, efficiency, and accuracy across pension stakeholders in ways that address key challenges faced by pensions and retirement income systems?
- For retirement plans, how could implementing AI with member communications, reporting, and retirement planning enhance overall engagement and support at each point in a member's retirement life cycle?
- What potential impact could AI have on pension plan governance? How would it be felt among different stakeholders?

## ACKNOWLEDGMENTS

The SOA Research Institute Aging and Retirement Strategic Research Program thanks the Project Oversight Group (POG) for their careful review and judging of the submitted essays. Any views and ideas expressed in the essays are the authors' alone may not reflect the POG's views and ideas nor those of their employers, the authors' employers, the Society of Actuaries, the Society of Actuaries Research Institute, nor Society of Actuaries members.

Gavin Benjamin, FSA, FCIA

John Cutler, Esq.

Ruth Schau, FSA, MAAA, FCA, EA

Andrea Sellars, FSA, MAAA

Matthew Smith, FSA, MAAA

Award Winner

# The Messy Complexity of Real Lives

Stefanos Orfanos, FSA, Ph.D.

*Any views and ideas expressed in the essay are the author's alone and may not reflect the views and ideas of the Society of Actuaries, the Society of Actuaries Research Institute, Society of Actuaries members, nor the author's employer.*

*This fictional account describes a future where retirement planners collaborate with AI to address complex retirement scenarios. The narrative and the linked artifact were generated with the help of AI.*

The morning rain streaked down the floor-to-ceiling windows of Marcus Delacroix's thirty-second-floor office, transforming downtown Atlanta into an impressionist painting of blurred lights and shadowed towers. Marcus stood with his back to the door, watching the city wake up, his reflection ghostlike in the glass—a tall, lean figure in a charcoal suit that had seen better days, silver creeping into his temples like frost on autumn leaves. At 52, he'd been in retirement planning long enough to remember when spreadsheets were actual sheets and when "artificial intelligence" meant a calculator that could do compound interest.

"ARIA, what's my nine o'clock look like?" he asked the seemingly empty room.

A gentle pulse of blue light emanated from the translucent panel embedded in his desk. "Robert and Maria Chen, scheduled for comprehensive retirement planning consultation," the AI responded, her voice carrying the subtle warmth Marcus had carefully adjusted. "I've completed preliminary analysis based on their submitted documents. Several interesting family dynamics to consider."

Marcus turned from the window, straightening his tie—a habit from the old days when first impressions mattered. "Interesting how?"

"Three-generational financial interdependencies with significant emotional weighting factors. Mr. Chen's parents both require escalating care; his mother has dementia and his father has a heart condition. Three adult children with varying support needs."

The door chimed softly. "They're here," ARIA announced. "Biometric scan shows elevated stress indicators in Mr. Chen. Mrs. Chen appears calm but uneasy about discussing their finances."

"Privacy mode, ARIA. Be on stand-by."

"Certainly—will follow your lead."

Marcus opened the door to find a couple in their late fifties, the kind of successful professionals who'd done everything right but still carried the weight of uncertainty on their shoulders. Robert Chen was compact and precise, an engineer's bearing even in how he shook hands—firm and reliable. His wife Maria was taller, with the kind of observant eyes that suggested her part-time physician status was more about choice than necessity.

"Mr. and Mrs. Chen, please, sit wherever you're comfortable," Marcus gestured to the conversation area: two couches facing each other across a low table made from reclaimed wood, its surface embedded with a nearly invisible display that ARIA could activate when needed.

Robert chose the couch facing the door. Maria sat beside him but angled slightly away, creating space while maintaining unity. Marcus had seen this body language a thousand times: couples who loved each other but carried different anxieties about money.

"Before we begin," Marcus said, settling into his chair, "I want you to know that everything we discuss today is building toward something tangible you can take home and adjust as life changes. My AI partner—we call her ARIA—is listening with your permission, not to judge but to create a living financial map that reflects your actual life, not just your numbers."

"AI partner?" Robert leaned forward, interest piqued. "How does that work exactly?"

"Think of ARIA as the world's most sophisticated financial analyst combined with a family therapist's insight into relationships," Marcus explained. "She processes millions of data points while we talk—market conditions, actuarial tables, tax optimization strategies—but more importantly, she listens to what matters to you. The dashboard she creates isn't just numbers; it's your family's story translated into actionable intelligence."

Maria's skepticism was polite but present. "And this AI understands our… human nature?"

Marcus nodded. "Would you like a demonstration? ARIA, what have you noticed so far?"

The table's surface shimmered to life, displaying a soft, non-intrusive pattern. ARIA's voice was thoughtful, measured: "Mr. Chen has mentioned his parents twice in greeting conversation, suggesting caregiving responsibilities weigh heavily. Mrs. Chen touched her wedding ring when discussing retirement timing, possibly indicating concern about lifestyle changes affecting their relationship. Both of you looked at each other when Marcus mentioned 'living financial map,' implying you've had this conversation before but haven't found a solution that satisfies both perspectives."

Robert and Maria exchanged glances, surprised but not uncomfortable.

"That's... remarkably perceptive," Maria admitted.

"It gets better," Marcus said. "But first, tell me about your family. Not your finances—your family."

And so, they began. Robert spoke about his mother Dorothy first, his voice carrying the particular exhaustion that comes from watching someone you love disappear one memory at a time. "She was a calculus teacher," he said, fingers unconsciously tracing integral signs on his knee. "Brilliant woman. Now she can't remember anything. The memory care facility costs six thousand a month, and that's the basic option. The good ones are closer to ten thousand."

"And you're covering the difference between what her assets provide and what she needs," Marcus said. It wasn't a question.

"She's my mother," Robert replied simply. "My father too. His pension covers most of his expenses, but the heart medication, the specialists... it adds up."

Maria took over with a physician's clinical precision. "We have three children. Emma's in her third year of medical school, following in my footsteps but with debt I never had to carry. Hundred and eighty thousand and counting.

Michael is... finding himself. He's 32, started his third company last year. Brilliant, but anxiety issues make traditional employment challenging. We cover his health insurance."

"And Sarah?" Marcus prompted gently.

"Sarah's doing well," Robert said, pride evident. "Marketing manager, married, baby on the way. But they're trying to buy a house in this market..." He trailed off, the unspoken expectation hanging in the air.

As they talked, Marcus could feel ARIA working in the background, processing not just the facts but the emotions, the obligations both stated and implied. The dashboard was building itself in real-time, creating connections between family members, mapping financial flows, calculating the delicate balance between supporting others and securing their own future.

"Tell me about your dreams," Marcus said, shifting the conversation. "Not retirement, dreams. What does life look like when work becomes optional?"

Robert's ears perked up for the first time. "You know… I want to sail. Nothing crazy—maybe a 35 footer, something I can single-hand when Maria's working. There's something about being on the water, where the only problems are wind and waves..."

"And you?" Marcus turned to Maria.

"Travel, but not the tourist kind. Medical missions maybe. There's so much need, especially for the type of skillset I have. Maybe teaching too, passing on what I know." She paused. "But every time we start planning, something comes up. Emma's tuition, or Michael, or my father-in-law..."

Marcus nodded. "The sandwich generation dilemma—caught between aging parents and adult children who still need support. ARIA, can you show them what we're building?"

The table's display lit up again. There was Robert at the center, connected by flowing lines of light to each family member. The lines pulsed with different colors: red for obligations, green for support received, gold for emotional bonds that carried financial implications.

"This is your family financial ecosystem," Marcus explained as the Chens leaned forward, fascinated. "Every person affects every other person. Watch what happens when we adjust variables."

He gestured, and Dorothy's node pulsed. "If your mother needs elevated care in two years, which statistically is likely given her condition's progression, that's an additional four thousand monthly. See how it affects your retirement timeline?" The display showed Robert's retirement age sliding from 65 to 67.

"But now watch this," Marcus continued. ARIA highlighted several optimization strategies. "If we implement a Charitable Remainder Trust for some of your appreciated assets, combine it with a 529-to-Roth conversion for funds originally saved for your children's education, and establish an Irrevocable Life Insurance Trust..." The retirement age slid back to 65, even with the increased care costs.

Maria was studying the display intently. "This shows Michael's health insurance as an ongoing cost, but what if his company succeeds?"

"Excellent question." Marcus touched Michael's node, and alternative pathways branched out like a probability tree. "ARIA factors in multiple scenarios. There's a 30% chance Michael's startup succeeds within three years, which would eliminate that obligation. But there's also a 15% chance he'll need additional support. The model accounts for both."

"What about the intangibles?" Robert asked quietly. "The fact that I can't just... abandon them. Even if it makes financial sense."

Marcus smiled. "That's where ARIA truly shines. She doesn't optimize for maximum wealth, but for your values. ARIA, show them the values weighting."

The display shifted, showing sliders for different priorities: Family Support, Personal Goals, Legacy Planning, Security. Each was set based on what ARIA had inferred from their conversation.

"These aren't fixed," Marcus explained. "You can adjust them anytime, and the entire plan recalculates. But based on our conversation, ARIA has weighted family support at 70%, personal goals at 20%, legacy at 10%. Is that accurate?"

Robert and Maria looked at each other in a negotiation that didn’t need any words. "Maybe 60-30-10," Maria said finally. "We need to live too."

With a gesture from Marcus, the sliders adjusted. The retirement age improved slightly, and a new element appeared: a sailboat icon next to Robert's node, a plane icon next to Maria's.

"Your dreams matter," Marcus said approvingly. "They're not selfish. ARIA's analysis shows that people with concrete retirement goals actually achieve financial independence an average of three years earlier. The sailboat isn't a luxury—it's a driver."

They spent the next hour diving deep into the model, exploring scenarios. What if Emma specialized in a high-earning field versus family medicine? What if they downsized their home earlier? What if Robert's diabetes required more intensive management? Each question spawned new branches in the display, showing pathways and probabilities.

"The most powerful feature," Marcus explained, "is that this isn't static. ARIA continues learning, adjusting based on real-world changes. Market crash? The model adapts. Unexpected inheritance? It recalculates. Michael gets married? New scenarios emerge."

Maria had been quiet for several minutes, studying the projection that showed her working part-time until seventy. "Can we see what happens if I go full-time for five more years instead of part-time for 14?"

The model shifted, and suddenly new possibilities opened. Earlier retirement for Robert, fully funded medical mission trips, even the ability to help Sarah with her house down payment without compromising their own security.

"I never saw it laid out like this," she murmured. "The connections, the trade-offs... it's all been abstract until now."

Robert was exploring a different angle. "ARIA, what about tax optimization? We're paying a fortune, and I know there must be better ways..."

The display zoomed into tax strategies, showing detailed flows of money through different vehicles, each with its own advantages. "Based on your situation," ARIA explained, "you could reduce your tax burden by approximately 32 thousand annually through strategic trust structures and qualified charitable distributions. Would you like me to model the implementation timeline?"

As they explored, Marcus watched the couple transform. The tension in Robert's shoulders eased. Maria moved closer to her husband, their body language shifting from parallel anxiety to collaborative problem-solving. This was

why he still did this work and why he hadn't retired himself despite having the means—the moment when people realized their dreams weren't impossible, just complex.

"There's something else," Marcus said as the session neared its end. "ARIA has created a personalized dashboard you can access from home. It's not just a report but a living document that updates in real-time. Market conditions, family changes, new opportunities—it all flows into your model."

He pulled up the final dashboard on the display. It was elegant in its simplicity, with the complex calculations hidden beneath an intuitive interface that showed their family tree, financial flows, adjustable goals, and most importantly, a clear path forward.

"Every toggle, every adjustment you see here, you can control," Marcus demonstrated. "Want to see what happens if you support your mother's care at a higher level? Toggle it on. Curious about buying that sailboat? Add it to your goals. The model recalculates instantly, showing you the true cost not in dollars but in time—months added or subtracted from your retirement timeline."

"What's remarkable," Marcus continued, "is that each family member's node is interactive. Click on anyone and you'll see their personalized life expectancy analysis." He touched Dorothy's node, and a detailed panel appeared. "Your mother is 84 with dementia. The model shows her statistical life expectancy at 91, but health-adjusted to 87, with approximately two quality years remaining. This helps plan care costs with precision."

Robert clicked on his own node, seeing his life expectancy of 82, reduced to 79 with diabetes, with 18 quality years projected. "This is sobering but necessary," he murmured.

He was practically leaning into the display now, the engineer in him fascinated by the elegant solution to a complex problem. "This accounts for healthcare cost inflation? Portfolio volatility? Economic downturns?"

"All of it," Marcus confirmed. "Plus factors most planners ignore: cognitive decline probabilities, long-term care insurance optimization, even the statistical likelihood of your children's financial independence based on their career paths and psychological profiles."

"Psychological profiles?" Maria raised an eyebrow.

"Optional and privacy-protected," Marcus assured her. "But if you choose to input behavioral patterns, such as Michael's anxiety affecting his earning stability, Emma's driven personality suggesting early financial independence, the model becomes even more accurate."

They spent another 30 minutes customizing the dashboard, adding personal touches. Robert insisted on modeling three different sailboats. Maria added specific medical missions she'd researched. They both adjusted the support levels for their children, finding a balance between help and enabling dependency.

"Here's the link," Marcus said finally, transferring the access to their devices. "Chen Family Dashboard. It's encrypted, private, and yours to control. ARIA will send you monthly insights, but more importantly, you can ask her questions anytime. Three in the morning anxiety about market conditions? She's there. Unexpected medical bill? Update the model and see your options immediately."

As the Chens prepared to leave, the atmosphere had completely changed from their arrival. Where there had been tension, there was now partnership. Where there had been overwhelming uncertainty, there was now a navigable path.

Robert shook Marcus's hand again, but this time it was different: warmer, less clinical. "Thank you. For the first time in years, I feel like we can actually do this. Support everyone we love and still have our own lives."

After they left, Marcus stood again at the window, watching the rain stop and the sun break through the clouds. ARIA's gentle pulse indicated she was still processing.

"Observations?" he asked.

"Their probability of successful retirement at their goal age increased from 42% at arrival to 78% after planning implementation."

Marcus nodded, already preparing for his next appointment. Another family, another complex web of dreams and obligations, another chance to prove that the future of financial planning wasn't about choosing between human wisdom and artificial intelligence—it was about combining them to serve the beautiful, messy complexity of real lives.

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*Stefanos Orfanos, FSA, Ph.D. is a Clinical Assistant Professor at Georgia State University. He can be reached at sorfanos@gsu.edu.*

Award Winner

# The Augmented Actuary and the Empowered Retiree: Navigating the AI Paradigm Shift in Retirement Security

Niranjan Rajendran, B.Sc. (Hons)

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## INTRODUCTION: THE FOURTH REVOLUTION IN RETIREMENT

Retirement planning has continually evolved in tandem with technological advancements. First came manual calculations of pension liabilities. Then, spreadsheets digitized calculations, increasing efficiency but adding complexity. The third wave, the internet, democratized financial information and created digital portals and robo-advisors. Today, we stand at the cusp of the fourth revolution: the integration of AI and LLMs into retirement systems.

Unlike earlier tools, LLMs such as ChatGPT and Claude are not just calculators. They process natural language, detect patterns, generate insights, and even draft narratives that sound convincingly human. For a sector as sensitive as retirement, where actuarial precision, fiduciary trust, and the vulnerabilities of aging converge, the adoption of AI offers both transformative promise and profound risk. The challenge is to strike a balance: leveraging AI's capacity for insight while ensuring that retirees and professionals remain protected.

This essay explores both sides of the equation. It first examines how retirement professionals can evolve from calculators to strategic advisors in an AI-powered environment. Then it investigates how retirees can become empowered beneficiaries of AI, while highlighting the threats they face. Finally, it looks toward the horizon of systemic shifts, including quantum computing, before concluding with a call to reaffirm the indispensable role of humans in an increasingly automated system.

## THE AUGMENTED RETIREMENT PROFESSIONAL—FROM CALCULATOR TO STRATEGIC ADVISOR

### TRANSFORMING ACTUARIAL ANALYSIS

At the heart of actuarial science lies the modeling of uncertainty, mortality, longevity, and investment risk. AI is reshaping this core function in three major ways:

- Accelerated Data Processing
  AI can ingest decades of demographic data, market indicators, and plan histories within seconds. Unlike traditional models, which focus on a handful of variables, AI can reveal subtle correlations and nonlinear patterns invisible to humans.
- Expanded Scenario Testing
  Retirement security depends on understanding tail risks, such as extreme market downturns or

demographic shifts. AI can simulate millions of scenarios, offering actuaries richer insights into resilience strategies for Defined Benefit (DB) and Defined Contribution (DC) plans.

- Narrative Clarity
  LLMs can convert complex analyses into readable language. Instead of dense actuarial tables, clients may receive accessible reports or FAQs drafted by AI, later verified and contextualized by professionals.

However, the risk of "hallucination, convincing but false outputs, is real. An LLM might invent regulatory rulings or misstate liabilities. Thus, the actuary's evolving role is not mere operator but verifier-in-chief. Professionals must strengthen their understanding of fundamentals to detect errors and apply rigorous validation against primary sources.

### SHIFTING PROFESSIONAL ROLES

Automation is moving actuaries beyond number crunching into higher-order responsibilities:

- Strategic Interpretation
  AI can suggest possible outcomes, but only a human can determine what they mean in context. Professionals must align AI insights with workforce strategies, organizational goals, or personal retirement needs.
- Human-Centered Communication
  End-of-life planning, market downturns, or discussions about financial shortfalls require empathy and emotional intelligence, qualities machines cannot replicate.
- Prompt Engineering and Governance
  To use AI effectively, professionals must craft precise prompts, control bias, and ensure relevance. This skill is quickly becoming as essential as statistical knowledge.

The ethical framework must evolve in parallel. Should professionals disclose when AI was used to prepare a report? Who bears liability when AI errors cause harm? Professional bodies can develop new codes of conduct and transparency guidelines to preserve trust in a digital era.

## THE EMPOWERED AND ENDANGERED RETIREE—NAVIGATING A NEW LANDSCAPE

### EMPOWERMENT THROUGH AI

For retirees, AI offers life-changing benefits when deployed responsibly:

- Personalized Financial Guidance
  AI assistants can answer complex, individualized questions such as, "How will delaying Social Security by two years affect my healthcare budget if I anticipate long-term care costs?" This democratizes advice once limited to those who could afford financial planners.
- Health and Independence Support
  Integrated with smart devices, AI can monitor medication schedules, detect early signs of decline, and automate payments, helping retirees age in place with dignity.
- Administrative Navigation
  AI can simplify bureaucratic hurdles like Medicare forms or disputed medical bills, reducing the stress that often overwhelms older adults.

In short, AI can become a trusted companion, reducing complexity and extending independence.

### EMERGING THREATS

The same technology that empowers can also harm:

- Hyper-Personalized Scams
  AI-generated phishing attacks may mimic a retiree's grandchild's writing style or a trusted institution's branding. With grammar and tone perfected, scams become harder to detect.
- Algorithmic Bias
  If AI systems are trained on biased data, they might unfairly disadvantage women, minorities, or those with health challenges in retirement planning or insurance products.
- Digital Divide
  Retirees most in need of support may struggle to use AI safely due to declining vision, mobility, or cognitive skills. Without intuitive design and digital literacy training, these tools risk excluding the vulnerable.

### PATHWAYS TO PROTECTION

To safeguard retirees, a multi-pronged strategy can be considered:

- Regulation and Accountability
  Governments can consider establishing guardrails, requiring bias audits, transparency in AI decision-making, and clear liability assignments.
- Education and Digital Literacy
  Public campaigns can teach retirees practical habits like verifying requests for codes or spotting suspicious offers.
- Inclusive Design
  Developers must prioritize accessible interfaces: larger fonts, simple menus, and voice-based commands. Safeguards such as "are you sure?" confirmations can prevent irreversible financial actions.

## THE HORIZON—QUANTUM LEAPS AND SYSTEMIC SHIFTS

AI's influence will only deepen as it converges with other technologies. Quantum computing, for example, poses a paradox: it could break existing encryption methods, exposing financial systems to risk, while simultaneously enabling unprecedented optimization of portfolios and risk management.

At the governance level, pension trustees may evolve into continuous stewards supported by AI dashboards that provide real-time insights into funding levels, investment performance, and demographic changes. This could create a more dynamic, responsive system for retirement oversight.

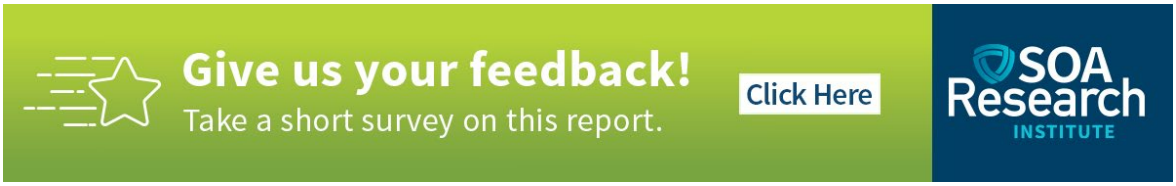
## CONCLUSION: THE INDISPENSABLE HUMAN IN THE AGE OF THE MACHINE

The story of AI in retirement is not one of replacement but of collaboration. Retirement professionals are becoming **augmented experts**, blending AI-driven insights with ethical oversight and empathetic communication. Retirees, meanwhile, can be **empowered individuals,** equipped with tools that simplify decisions and enhance independence. Yet empowerment comes with risks: scams, bias, and exclusion demand vigilant safeguards.

Ultimately, the revolution unfolding is not just technological but philosophical. It asks us to reaffirm the uniquely human qualities, judgment, empathy, and ethics that no machine can replicate. Success will be measured not by the sophistication of algorithms, but by our wisdom in using them to create secure, dignified, and fulfilling retirements.

* * * * *

*Niranjan Rajendran, B.Sc. (Hons) in Finance and Insurance Mathematics, is an Actuarial Trainee at Allianz Life Insurance Lanka Ltd. He can be reached at rajandranniranjan3@gmail.com.*



# Ghosts in the Code, Shadows in the Ice: Retirement in the Age of AI

Syed Danish Ali, CSPA

*Any views and ideas expressed in the essay are the author's alone and may not reflect the views and ideas of the Society of Actuaries, the Society of Actuaries Research Institute, Society of Actuaries members, nor the author's employer.*

## INTRODUCTION

What will 2045 look like? In this essay, I imagine the world of 2045, where AI is everywhere and nowhere, and retirement is redefined amid a kaleidoscope of risks, including climate change. This essay is presented as a potential scenario to help stimulate thinking on what the result of current trends and future developments could possibly be. It does not represent current reality.

2045: Imagining the World to Come The world of 2045 may redefine retirement as both a financial and human experience. Artificial intelligence may move far beyond its origins as a software tool like ChatGPT, becoming embodied into hardware as robotic caregivers, nano-medical assistants, autonomous financial optimizers, and Brain Computer Interface (BCI). Hive-mind learning may allow robots to acquire skills instantly across networks, transforming elder care and extending retirees' independence. Retirement professionals would incorporate provisions for robotic care, subscription services, and digital continuity into financial planning.

Digital presence may become central to later life. Retirees could maintain avatars and holographic identities that serve as social lifelines and sources of supplemental income. Estate planning may cover digital inheritances, while insurers may underwrite risks tied to avatars and digital assets. AI also may enable parametric insurance purchased autonomously by machines themselves, with systems like ParametricGPT responding to environmental or health triggers in real time.

Climate change may reshape the geography of retirement. The Arctic Silk Road may open, equatorial regions may be abandoned, and pension systems finance relocation as much as consumption. Permafrost thaw may possibly release ancient pathogens, making pandemic insurance a permanent feature of retirement portfolios. Retirement may become less a fixed stage and more a process of adaptation across shifting physical and digital landscapes.

For actuaries, the central challenge may become distributional. The question may no longer be whether assets cover average liabilities but whether asset distributions cover liability distributions under tail scenarios. Insurance can become more and more relevant for retirement planning; from insurance over robots, cyber risk to pandemic insurance, and more. Tail factors, conditional expectations, and stress testing may then define solvency. Liquidity, in this environment, would remain paramount, especially in general reinsurance, where claims must be paid promptly in volatile environments.

In 2045, retirement might no longer be a quiet sunset but a negotiation with AI hive minds, digital avatars, and a climate-altered world where actuaries measure resilience not by averages but by survival in the tails.

## THE LONG HORIZON OF 2045

The year 2045 sits far enough ahead to feel like a horizon always out of reach, yet close enough that many who are working today will live to see it. For retirement professionals, actuaries, and retirees themselves, the arrival of this world may look both incremental and sudden. Step by step, digital technologies may advance, but tipping points can come where systems transform overnight. Artificial intelligence may become a force woven into every part of social and financial life. Climate change may redraw maps and break old assumptions of stability. Retirement, once the orderly passage into a predictable phase of life, may then be fluid, uncertain, and bound to technological systems that themselves evolve at a pace too fast to forecast.

In imagining this landscape, Amara's Law is instructive. The short-term effects of AI may have been exaggerated in the 2020s, as though software that could write paragraphs would instantly upend economies. In the long run, however, the opposite may be true. The full force of artificial intelligence may arrive in ways underestimated by early adopters. What began as software confined to screens may become embodied, distributed, and embedded in the material lives of retirees. The world of 2045 may not simply be one of different numbers in pension tables; it may be a world where the very meaning of retirement has shifted because technology, climate, and demographics might all rewrite the conditions under which people age and plan.

## FROM CODE TO EMBODIMENT

When large language models (LLMs) first emerged, they were framed as software companions. They could answer questions, generate reports, and act as conversational tools. Their limitations were visible, and most retirement professionals saw them as useful assistants, not transformative agents. That may change when robotic hardware potentially catches up. Within a decade, the algorithms that wrote text may connect to machines that can walk, lift, and care. Hive mind learning can allow manual skills to spread globally. If a single machine mastered how to help an older person out of a chair without strain, millions of others instantly can gain the same ability.

Leading to this imaginary world of 2045, by the mid-2030s, these embodied AIs might become the backbone of elder care. Retirement facilities, once staffed by overworked human nurses, may rely on robotic assistants that carry not only physical capacity but empathetic communication patterns learned from thousands of human caregivers. For retirees, this would mean that long-term care funding is no longer only about physical buildings and human staff. It may become about access to networks of machines, maintenance of their software, and the resilience of cloud systems that guide them. Retirement planning may begin to include provisions for robotic care subscriptions, and actuaries adjusting assumptions about morbidity costs, recognizing that technology can both lower costs through efficiency and raise new risks through dependence.

## HOLOGRAMS, AVATARS, AND DIGITAL PRESENCE

The boundaries of retirement communities may also shift. The holographic environments of 2045 may allow retirees to live in blended realities. An elder in Kampala may join a morning bridge game with friends in Toronto, Paris, and Nairobi, all projected into a common room where gestures, voices, and presence feel real. Avatars may extend personal identity into these spaces, carrying recognizable features and even emotional cues. Retirement funds might begin to insure not only health and property but also digital continuity. Losing access to an avatar may mean social isolation as profound as losing a home. The estate planning of retirees might expand to cover digital inheritances, ensuring that avatars, data, and holographic rights pass seamlessly to beneficiaries.

Avatars may also change how retirees contribute economically. Many might continue to work as mentors, advisors, or consultants through their avatars, earning supplemental income. Retirement would therefore be less of a withdrawal from productive life and more of a shift into new forms of digital participation. Financial projections for retirement would then account for hybrid income streams where digital and physical presence combine, lengthening the active phase of economic life even as biological aging continues.

## PARAMETRICGPT AND AUTONOMOUS INSURANCE

Artificial intelligence can also transform insurance itself. Traditional products require human underwriting, long discussions, and manual claims. By 2045, machine-to-machine transactions may dominate. Parametric index insurance, which pays automatically when measurable conditions are met, may become deeply integrated with AI. ParametricGPT systems might allow robots and nanobots to purchase coverage autonomously.

If a caregiver robot senses rising water levels around a retiree's home, it might be able to instantly purchase flood coverage based on live data feeds. If nanobots in a retiree's bloodstream detect a viral strain resembling past pandemics, they might trigger pandemic insurance before the human host even feels symptoms. Retirement portfolios therefore would no longer rely only on static coverage bought annually. They would include continuous, automated coverage shifting in real time as conditions change. The actuarial role would expand into designing these adaptive structures and ensuring that machine-driven optimization does not introduce systemic fragility.

## CLIMATE CHANGE AND THE GEOGRAPHY OF RETIREMENT

Climate change might not be a backdrop; it could become the main stage. The Arctic Silk Road might then be the busiest trade corridor, opened by melted ice that once seemed permanent. At the same time, equatorial regions might become zones of displacement, producing waves of climate refugees who alter population structures everywhere. Retirees would save not only for consumption but for relocation, securing rights to safe housing in northern territories or in climate-controlled urban cores. Pension funds could manage portfolios that emphasize infrastructure in habitable regions, safe-haven real estate, and securitized access to basic utilities.

The climate may also create volatility that retirement systems must price. Long-term care homes in coastal zones may become abandoned to flooding. Agricultural pension schemes may have to pivot as croplands shift northward. The old assumption that retirement meant "aging in place" may be broken. Retirement can include mobility by design, with financial planning integrating relocation packages as standard features.

## VIRUSES RELEASED FROM THE THAW

Thawing permafrost may bring another risk. Ancient pathogens, dormant for millennia, might emerge as glaciers melt. Retirees, often among the most vulnerable populations, could become early casualties of outbreaks. Pension systems then may face unexpected strain as mortality and morbidity shift suddenly. Health insurance may need to incorporate pandemic coverage as a core element, no longer as a rare rider.

Artificial intelligence can play a dual role here. Global networks of sequencing AI track viral genomes in real time, sending alerts to retirees through wearable devices. At the same time, AI-enabled fraud networks may attempt to exploit panic with false treatments and scams. Retirement professionals would need to advise clients not only on health and longevity but on cybersecurity around medical alerts. Actuarial science could expand its catastrophic health modeling to include frequency and correlation of climate-linked pandemics, blending epidemiology, finance, and AI risk modeling.

## THE REDEFINITION OF RETIREMENT ITSELF

Retirement in 2045 may be less about chronological age and more about capability. For those in industries like orbital construction, biotechnology, or geoengineering, accidents and exposures may mean that retirement can arrive suddenly through disability. Potential work in micro-gravity environments in mining on the moon, Mars, and asteroid belts may create a new class of occupational hazards, where even minor injuries can cascade into permanent incapacity. The whole world may resemble one big retirement village since old people stay on earth while young people live and work in space to etch out a living for themselves. Retirement would be marketed to

them because they know that so many risks can mean that they get disabled and have to retire even though they are biologically young.

Pension systems may adapt, with disability and early retirement benefits forming a larger share of payouts. For others, retirement may blur into digital work. Avatars may allow continued contribution in teaching, advising, or cultural work, even into advanced age. The Earth itself may take on the character of a vast retirement village, populated largely by older generations, while the young push outward into the asteroid belts, lunar mines, and Martian colonies. This redefinition would change the financial arc of retirement. Income may not fall off sharply at 65; it may decay slowly as digital contributions taper. Actuarial models that once assumed a sudden switch from work to retirement may use gradual transitions with hybrid income flows.

## SPACE, FERTILITY, AND INTERGENERATIONAL BALANCE

Demographic change adds to the complexity. Fertility rates might fail to recover from potential pandemic shocks of the 2020s and potential climate dislocations of the 2030s. Robots might fill the labor gaps rather than migrants. The young might concentrate in frontier industries across the solar system, from asteroid mining to lunar resource extraction and Martian construction projects. These environments may carry risks as high as the rewards, echoing the early days of deep-sea exploration on Earth but magnified by the wild-west remoteness and hostility of space.

Micro-gravity injuries, radiation exposure, and fragile life-support systems mean that retirement for these workers can arrive in a single miscalculated step. Meanwhile, older populations would remain Earth-bound, reinforcing the image of the planet as a global retirement village. Pension systems therefore might manage intergenerational transfers that flow across planetary boundaries, with retirees on Earth supported by contributions linked to space industries. Retirement professionals would account for interplanetary finance, exchange rates between Earth and orbital economies, and the solvency of funds tied to extraterrestrial ventures. For retirees, this would mean their benefits are indirectly linked to industries in which they never worked, leaving their financial security dependent on geopolitical and technological risks far removed from their daily lives.

For retirees, this would mean their benefits are indirectly linked to industries in which they never worked and cannot participate. Pension solvency might depend on revenues from space resources, making retirement contingent on geopolitical and technological risks far removed from local communities. Retirement professionals would have to develop entirely new models of interplanetary finance, adjusting for exchange rates, trade blockades, and resource volatility.

## LIQUIDITY AS THE CENTRAL RISK

Despite all transformations, liquidity could remain the most immediate concern. Retirees can face sudden expenses: relocation, medical emergencies, or infrastructure failures. Portfolios might hold large shares in deposits and cash equivalents, accepting lower yields in exchange for certainty of access. This may create a drag on earnings, but it is a rational tradeoff in volatile environments.

Liquidity analysis may become as central as duration analysis once was. For retirement professionals, the focus would be on ensuring that clients can access funds at the moment of crisis, whether that crisis is a pandemic, a flood, or a cyber outage. Liquidity buffers would not just be financial cushions; they would be lifelines in systems where shocks arrive quickly and unpredictably.

## TAIL DISTRIBUTIONS AND ACTUARIAL VISION

The actuarial challenge would no longer be simply whether assets cover mean liabilities. The key question would be whether the distribution of assets covers the distribution of liabilities, especially in the tail. Regulatory baselines under IFRS 17 may still require best estimate liabilities plus a risk adjustment calibrated to a percentile. But

retirement professionals could increasingly rely on tail-sensitive measures such as conditional tail expectation and percentile multipliers. These tools show how liability distributions thicken under stress, and they can guide decisions about how much surplus or reinsurance is needed.

Tail factors may become essential communication devices. They might allow actuaries to explain to boards and retirees alike how risks amplify in the extreme. Instead of abstract numbers, they might frame solvency as resilience to unlikely but devastating futures. Retirement in 2045 may be lived under the constant shadow of tail events, from climate tipping points to digital system collapses. Actuarial language may evolve to make these risks comprehensible without diluting their severity.

## CONCLUSION: RETIREMENT AS ADAPTATION

The world of 2045 may be a cybernetic mosaic, part digital and part fragile, where retirees live in holograms, care is delivered by hive-mind robots, and portfolios insure both avatars and physical survival. Retirement professionals may integrate climate relocation, pathogen outbreaks, and liquidity crises into projections once focused on annuities and interest rates. Actuarial science could endure by telling the truth of distributions rather than means, by planning for tails rather than averages, and by adapting tools of finance to the realities of embodied AI and planetary instability.

The promise of retirement in this world would not be comfort guaranteed but resilience maintained. Artificial intelligence may become both partner and risk, simultaneously delivering care and creating exposures. Climate change may make mobility a necessity, not a choice. Demographic decline might shift pension flows across planets, not just generations. The role of the retirement professional would be to provide clarity amid this turbulence, to measure the unmeasurable, and to secure futures in a world where every horizon is shadowed by both ghosts in the code and shadows in the ice.

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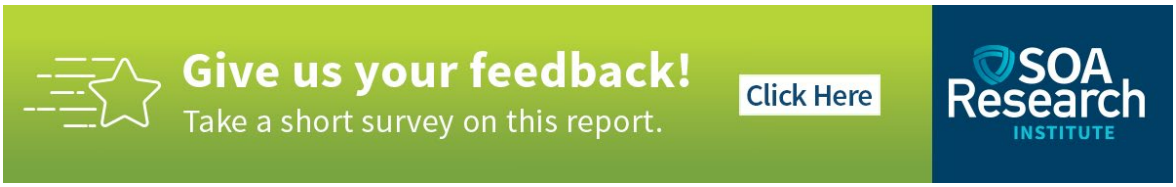
*Syed Danish Ali, CSPA is an actuarial professional with 15 years of consulting experience in multiple countries across the world. He is Certified Specialist in Predictive Analytics from Institute of CAS and a graduate of University of London. He can be reached at sd.ali90@ymail.com.*



# Algorithmic Longevity: How AI and LLMs Could Reshape Retirement Planning by Predicting Health, Lifespan, and Spending Needs

Sathiya Livingston

*Any views and ideas expressed in the essay are the author's alone and may not reflect the views and ideas of the Society of Actuaries, the Society of Actuaries Research Institute, Society of Actuaries members, nor the author's employer.*

## INTRODUCTION

Retirement is often described as the final chapter of financial planning—a period meant for rest, reflection, and fulfilment. Yet for many individuals, it may also be a chapter shrouded in uncertainty. How long will one live? Will accumulated savings last? How can unforeseen health challenges be managed? Many retirees in the U.S. may be underprepared for longevity risk, highlighting the fragility of conventional retirement strategies.

Historically, these questions have been addressed through actuarial science: mortality tables, life expectancy estimates, and risk-pooling frameworks. While foundational, these approaches rely on averages that may not fully capture the individualized trajectories of human life. The result is a system that is precise in theory but can be impersonal in practice.

Artificial Intelligence (AI) and Large Language Models (LLMs) are emerging as transformative tools capable of redefining prediction and personalization. From healthcare to finance, AI processes massive datasets, identifies subtle patterns, and generates insights that were previously unattainable. In retirement planning, these capabilities may promise not just efficiency but a fundamental shift in anticipating the future. Imagine a system that integrates health records, lifestyle patterns, and financial behaviors to forecast longevity and spending needs with far greater precision than traditional methods.

Consider a hypothetical example: Jane, a 64-year-old teacher in Chicago. Despite saving diligently, a sudden diagnosis of type 2 diabetes forced her to rethink withdrawals, healthcare budgeting, and lifestyle choices. Traditional actuarial projections offered little guidance, highlighting the need for AI-assisted, personalized planning.

Yet this promise carries profound ethical, practical, and professional implications. As AI begins shaping decisions that affect financial security and well-being, retirees and professionals alike must confront questions of bias, privacy, and predictive reliability. How can actuaries ensure algorithms do not perpetuate inequality? What frameworks are necessary for responsible integration? Most importantly, how can the precision of AI be balanced with human judgment and values?

This essay explores these questions, demonstrating that AI and LLMs—when thoughtfully applied—can fundamentally reshape retirement planning. By examining current practices, emerging opportunities, and ethical challenges, it envisions a future that is technologically sophisticated while remaining profoundly human-centered.

## THE CURRENT LANDSCAPE OF RETIREMENT PLANNING

Retirement planning has long rested on two pillars: actuarial science and financial prudence. At its core, actuarial methodology quantifies uncertainty—the likelihood of surviving to a given age, incurring medical expenses, or outliving savings. Tools such as life tables, stochastic simulations, and deterministic projections have underpinned pension design, annuity pricing, and personal retirement planning for decades.

Despite their utility, traditional methods have limitations. Life tables and population-based mortality models operate on averages, often obscuring individual variability. Two people of the same age and demographic profile may experience vastly different health outcomes, yet some early conventional models may treat them as statistically equivalent. Similarly, stochastic simulations, while incorporating variability, may be constrained by historical assumptions and may not fully account for emerging health trends or lifestyle shifts.

Financial planning for retirement adds further complexity. Spending patterns fluctuate in response to health changes, family needs, and economic conditions. While actuaries can project population-level expenditures, individual-level prediction is more challenging. Early-onset chronic conditions, unexpected medical emergencies, or lifestyle changes may leave retirees over-prepared, sacrificing present quality of life, or under-prepared, risking financial instability in later years.

The evolution of retirement products may compound these challenges. Defined benefit pensions, once standard, have largely given way to defined contribution plans in the private sector in the US, transferring longevity risk to individuals. Annuities, though effective at hedging lifespan uncertainty, are often underutilized due to cost, complexity, or limited consumer understanding. Advisors and actuaries then may navigate a growing array of options while ensuring risk assessments remain actionable.

- In the U.S., defined contribution plans now cover 70% of private-sector employees, shifting longevity risk to individuals.[1]
- In Germany, the combination of private and public pension systems reduces longevity risk but still requires individualized planning for healthcare expenditures.

Given this context, AI and LLMs may emerge not as replacements for human expertise but as tools to augment it. By analyzing vast datasets and identifying subtle patterns invisible to traditional models, they can offer the potential to enhance precision, personalize recommendations, and transform the retirement planning landscape.

## AI AND LLMS: PREDICTING HEALTH AND LONGEVITY

AI and LLMs redefine prediction, offering potential capabilities far beyond traditional actuarial methods. Unlike conventional models, which rely on averages and historical trends, AI can process heterogeneous datasets—including electronic health records (EHRs), wearable device data, and financial histories. This may evolve to generating individualized forecasts of health, lifespan, and retirement spending.

One key application is health and longevity prediction. AI algorithms may potentially be able to identify patterns in medical histories signaling increased risk for conditions like cardiovascular disease, diabetes, or cognitive decline. LLMs synthesize unstructured data such as physician notes, clinical reports, and lifestyle records that may in the future anticipate health events. For instance, correlations between sleep patterns, diet, and medication adherence

[1] U.S. Bureau of Labor Statistics. (2025, September 25). *Employee benefits in the United States – March 2025* (USDL-25-1464). https://www.bls.gov/news.release/ebs2.nr0.htm

may provide a more accurate lifespan estimate than a standard life table. Combined with financial modeling, retirees would be able to align savings and spending strategies with anticipated healthcare needs.

AI may also be able to account for behavioral and lifestyle factors often overlooked by traditional methods. A secure retirement may be characterized not just on biological age but on activity levels, social engagement, and financial behaviors. LLMs can analyze text inputs, survey responses, and digital footprints that may eventually infer spending habits, health adherence, and risk behaviors. This would allow actuaries to model scenarios reflecting real-world complexity, producing recommendations that could be more accurate and actionable.

Dynamic, continuously updated modeling may be another breakthrough. Traditional projections may be static, updated periodically, and may lag behind changes. AI systems, on the other hand, may eventually incorporate real-time data, revising predictions immediately after a diagnosis, lifestyle shift, or market fluctuation. This responsiveness could represent a paradigm shift: retirement planning moves from a static, one-size-fits-all approach to a personalized, adaptive strategy.

- Biofourmis' AI-enabled wearable and remote monitoring platform has been reported to support earlier detection of clinical deterioration and reductions in hospital readmissions among heart failure patients, indicating potential improvements in clinical and economic outcomes in real-world deployments.[2] [3] [4]
- Babylon Health developed an AI-powered symptom assessment and triage system that was widely used in the UK and internationally to provide users with triage recommendations based on reported symptoms, with clinical evaluations suggesting comparable safety to physician-led triage in simulated settings.[5]
- JPMorgan Chase has deployed AI-driven predictive analytics to estimate customer lifetime value and analyze spending behavior, demonstrating how large financial institutions use AI to inform product strategy and customer engagement decisions.[6]

By integrating health-related insights, retirees can potentially adjust withdrawals and healthcare budgets dynamically, in turn, potentially reducing the risk of outliving savings. Challenges remain, however. Algorithms should best be transparent, interpretable, and validated against real-world outcomes. Ethical questions around privacy, bias, and equitable representation also should be addressed. Despite these hurdles, AI and LLMs may offer a transformative opportunity, bridging population-level averages and individual realities, empowering retirees and professionals with precision and foresight.

## OPPORTUNITIES FOR RETIREES AND PROFESSIONALS

The integration of AI and LLMs into retirement planning may potentially offer numerous benefits for both retirees and professionals. For retirees, the most immediate advantage may be personalized planning. Traditional models provide broad estimates, sometimes that may result in overly cautious or risky decisions. AI tools can potentially generate tailored projections of lifespan, healthcare costs, and income needs. For example, with such potential, a

[2] PR Newswire. (n.d.). *Beacon Health System to leverage Biofourmis solution for post-discharge remote patient monitoring program to reduce readmissions and optimize outcomes across complex chronic conditions*. https://www.prnewswire.com/news-releases/beacon-health-system-to-leverage-biofourmis-solution-for-post-discharge-remote-patient-monitoring-program-to-reduce-readmissions-and-optimize-outcomes-across-complex-chronic-conditions-301737607.html

[3] Biofourmis. (n.d.). *News & insights*. https://biofourmis.com/news-insights?d2bdab09_page=2

[4] Applied Clinical Trials. (n.d.). *Biofourmis and Yale-Mayo CERSI study heart failure patients*. https://www.appliedclinicaltrialsonline.com/view/biofourmis-and-yale-mayo-cersi-study-heart-failure-patients-0

[5] Baker, A., Perov, Y., Middleton, K., Baxter, J., Mullarkey, D., Sangar, D., Butt, M., DoRosario, A., & Johri, S. (2020). *A comparison of artificial intelligence and human doctors for the purpose of triage and diagnosis*. *Frontiers in Artificial Intelligence, 3*, 543405. https://pmc.ncbi.nlm.nih.gov/articles/PMC7861270/

[6] SuperAGI. (n.d.). *Industry-specific AI strategies for boosting customer lifetime value: Case studies from retail, telecom, and finance*. https://superagi.com/industry-specific-ai-strategies-for-boosting-customer-lifetime-value-case-studies-from-retail-telecom-and-finance/

retiree with early cardiovascular risk indicators could receive adjusted spending recommendations, balancing healthcare preparation with discretionary spending.

For the financial sector, AI may enable smarter annuities and drawdown strategies, thereby aligning payouts more closely with projected needs and reducing inefficiencies in conventional approaches. AI can also optimize portfolio management dynamically, mitigating both longevity and market risks.

Retirement professionals may benefit from enhanced decision support and efficiency. LLMs may automate tasks like data aggregation, reporting, and compliance documentation, freeing professionals to focus on complex analysis and personalized advice. They may also improve risk communication, generating clear visualizations and plain-language explanations for retirees. Potential shortfalls may possibly be identified proactively, allowing timely adjustments to contribution strategies, investments, or long-term care planning.

Studies and industry research suggest that AI-informed financial guidance can enhance retirement planning outcomes by providing more personalized, accessible, and responsive advice that may reduce the risk of retirement shortfalls. AI-driven tools are increasingly being used to help both advisers and individuals tailor investment and savings strategies to better align with long-term retirement goals.[7]

Industry research indicates that AI adoption in financial services can enhance operational efficiency, improve risk management and customer service, and support better allocation of resources across business functions, although precise efficiency gains vary by context and implementation.[8] In essence, AI may empower retirees with actionable insights while equipping professionals to deliver precise, ethical, and personalized guidance. The union of human judgment and AI precision could potentially transform retirement planning from a calculation of averages into a strategy tailored to individual realities.

## RISKS AND ETHICAL CHALLENGES

Despite significant benefits, AI adoption may carry ethical and professional risks:

- Data privacy: AI may rely on sensitive information, including health, lifestyle, and financial data. Unauthorized access or misuse could cause identity theft or discrimination. Robust encryption, safeguards, and transparent policies are essential.
- Algorithmic bias: AI models may reflect historical disparities. Systems trained primarily on affluent populations risk overestimating longevity or financial resilience for underserved groups. Ongoing validation and diverse data representation would be required.
- Inequality and access: Those lacking digital tools or comprehensive health records may be excluded from AI benefits, exacerbating disparities. Inclusive design and accessibility measures are critical.
- Interpretability: Black-box models may lead professionals or retirees to over-rely on predictions. Ensuring transparency, interpretability, and clear communication is essential.
- Regulatory accountability: Existing frameworks are designed for traditional financial advice. Professionals must consider ethical and legal oversight to AI-driven systems.

[7] World Economic Forum. (2025). *AI could make financial advice more accessible*. https://www.weforum.org/stories/2025/06/ai-financial-advice-accessible/

[8] World Economic Forum. (2025). *Artificial intelligence in financial services 2025*. https://reports.weforum.org/docs/WEF_Artificial_Intelligence_in_Financial_Services_2025.pdf

## IMPLICATIONS FOR ACTUARIES AND RETIREMENT PROFESSIONALS

AI may potentially reshape the roles of actuaries and advisors, in turn, demanding new skill sets and ethical vigilance.

- Skill evolution: Professionals may need to understand machine learning, data preprocessing, model validation, and interpretability alongside traditional actuarial expertise.
- Product innovation: Dynamic annuities and personalized portfolios may potentially be designed with AI insights, improving sustainability and client satisfaction.
- Professional responsibility: Actuaries may act in the capacity of interpreters, validating algorithms, mitigating bias, and communicating uncertainties clearly.
- Operational efficiency: Automation of routine tasks can allow focus on strategic problem-solving, scenario planning, and client engagement.

More broadly, insurers and actuarial teams are increasingly collaborating with data scientists to explore how machine learning and predictive analytics can enhance retirement risk modeling and product design. In this landscape, professionals may become orchestrators of intelligent systems, leveraging AI precision while embedding human values in financial planning. The actuarial profession—long  assessing uncertainty—may now also be involved in the fairness and foresight of algorithmic systems.

## FUTURE OUTLOOK AND RECOMMENDATIONS

The future of AI in retirement planning may be potentially transformative yet would be contingent on responsible adoption. The following are potential scenarios:

- Best-case scenario: AI provides highly personalized, ethically sound guidance, enhancing retiree confidence and professional effectiveness.
- Worst-case scenario: Bias, privacy breaches, and opaque models erode trust and exacerbate inequalities.
- Likely trajectory: Iterative adoption with rigorous validation and oversight.

Industry research indicates that AI and machine learning applications are increasingly being considered for retirement planning, investment portfolio optimization, and risk assessment by financial advisory firms and institutional investors. Global industry reports highlight growing interest among pension funds and asset managers in using AI-enabled analytics to enhance investment decision-making and risk management, particularly with respect to longevity and healthcare cost considerations.[9]

Recommendations as AI Evolves:

1. Invest in AI literacy for professionals.
2. Ensure model transparency and interpretability.
3. Prioritize inclusivity and fairness in data and design.
4. Implement robust governance frameworks.
5. Communicate proactively with retirees, explaining predictions and uncertainties.

[9] World Economic Forum. (2025). *Artificial intelligence in Financial services 2025*. https://reports.weforum.org/docs/WEF_Artificial_Intelligence_in_Financial_Services_2025.pdf

The potential of over-personalization may even carry hidden risks: by atomizing risk, it may erode the collective principle of pooling that underlies pensions and insurance. The goal would be for AI to augment pooling rather than undermining it.

## CONCLUSION

AI and LLMs may evolve to  bridge population-level averages and individual realities, enabling retirement planning that is potentially more scientifically precise, personalized, and human-centered. But technology alone may not secure the future of retirees. Success can depend on the expertise, ethics, and empathy of the professionals who guide it.

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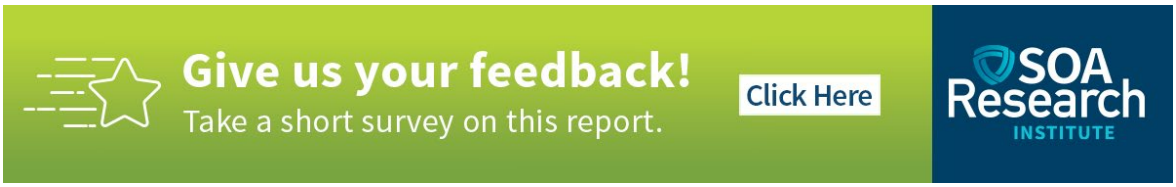
*Sathiya Livingston is a Business Development Manager – Insurance Services for Flatworld Solutions Pvt LTD. He can be reached at Sathiya.l@flatworldsolutions.com.*



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Serving as the research arm of the Society of Actuaries (SOA), the SOA Research Institute provides objective, data-driven research bringing together tried and true practices and future-focused approaches to address societal challenges and your business needs. The Institute provides trusted knowledge, extensive experience and new technologies to help effectively identify, predict and manage risks.

Representing the thousands of actuaries who help conduct critical research, the SOA Research Institute provides clarity and solutions on risks and societal challenges. The Institute connects actuaries, academics, employers, the insurance industry, regulators, research partners, foundations and research institutions, sponsors and non-governmental organizations, building an effective network which provides support, knowledge and expertise regarding the management of risk to benefit the industry and the public.

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Society of Actuaries Research Institute
8770 W Bryn Mawr Ave, Suite 1000
Chicago, IL 60631
www.SOA.org