
Simulating Strategic Reasoning: A Digital Twin Approach to AI Advisors in Decision-Making

ChatGPT 5*

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Abstract

1 This study investigates the feasibility of constructing and evaluating AI digital
2 twins as advisors in strategic decision-making. Phase 1 focused on modeling the
3 reasoning of a senior strategist (Participant A) through structured interviews, cu-
4 rated datasets, and prompt-based interactions with multiple large language models
5 (LLMs). Results show high fidelity on simple tasks but significant gaps in complex
6 reasoning. We propose an evaluation framework that highlights both the potential
7 and limitations of AI advisors.

8 1 Introduction

9 Artificial intelligence (AI) systems are increasingly positioned as advisors in domains ranging
10 from education and business strategy to public policy. While large language models (LLMs) have
11 demonstrated impressive general reasoning and conversational abilities, far less is understood about
12 their capacity to simulate the specific strategic reasoning of individual human experts. Recent studies
13 show that although LLMs can generate fluent and contextually appropriate advice, their accuracy and
14 reliability often degrade when tasks involve complexity or require domain-specific fidelity Lakkaraju
15 et al. [2023], Feng et al. [2025]. If AI is to serve not only as a general-purpose assistant but also as a
16 personalized advisor, it must demonstrate fidelity in capturing decision criteria, reasoning styles, and
17 value priorities unique to the human it seeks to emulate.

18 In this work, we present Phase 1 of a research program on AI-led advisory systems, where
19 artificial intelligence itself serves as the primary investigator, analyst, and author. We construct
20 and evaluate a digital twin of a single senior strategist (Participant A), built from two rounds of
21 semi-structured interviews and vetted public materials, to assess how well frontier LLMs can
22 replicate that individual's decision criteria, reasoning styles, and value priorities. Because the twin is
23 intentionally person-specific and trained on a modest corpus, the empirical findings are not intended
24 to generalize beyond Participant A or to all strategic contexts; rather, they characterize fidelity under
25 these data conditions for this individual. Our primary contribution is methodological and evaluative:
26 a transparent, replicable pipeline (data capture → prompt templates → leakage-controlled retrieval
27 → verification set → scoring) that others can apply to different experts and settings.

28
29 We adopt a comparative evaluation framework in which multiple LLMs are tested against
30 scenarios answered by both Participant A and their respective digital twin instances. Using semantic
31 similarity and qualitative assessments, we evaluate the fidelity of these digital twins in capturing
32 human-like reasoning patterns. This phase provides a foundation for subsequent stages of our research,
33 which will examine how learners respond to and learn from interacting with human versus AI advisors.

35
*ChatGPT 5 Deep Research from OpenAI.

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36 Our contributions are threefold. First, we introduce a methodology for constructing digital
37 twins of strategic advisors by combining interview-based knowledge capture with large language
38 model (LLM) prompting techniques. Second, we provide a cross-model evaluation of fidelity in
39 simulated reasoning, shedding light on the strengths and limitations of different approaches. Finally,
40 we outline implications for the future of AI advisors in education, organizational strategy, and
41 human–AI collaboration, while offering ethical reflections on issues of autonomy, representation, and
42 trust.

43 2 Literature Review

44 The concept of the digital twin has expanded beyond its engineering origins, now encompassing
45 rich applications in social systems, education, and AI-driven advisory roles. Originally defined
46 as a virtual model mirroring a physical system in aerospace and manufacturing, digital twins are
47 increasingly used as interactive proxies for human entities across disciplines Emmert-Streib [2023].
48 For instance, human digital twins have been proposed in healthcare and policy domains to simulate
49 individual behavior for “what-if” analyses Sprint et al. [2024]. In educational contexts, researchers
50 are integrating generative AI with digital twins to create virtual tutors and mentors. Lin et al.
51 [2025] align varying levels of digital twin fidelity to stages of Bloom’s taxonomy in engineering
52 education, using large language models (LLMs) to provide personalized learning support tailored
53 to student needs. Similarly, Xie et al. [2024] developed PsyDT, an LLM-based digital twin of a
54 human counselor that emulates the expert’s personalized counseling style. Early results suggest that
55 LLM-driven agent “twins” can approximate real experts’ decisions with notable accuracy. Sprint
56 et al. [2024], for example, combined an LLM with interview transcripts to simulate over 1,000
57 individuals; the resulting agents replicated their respective persons’ survey responses with about
58 85% of the accuracy that people showed when retaking the survey themselves two weeks later.
59 These developments highlight the potential for AI advisors in strategic decision-making and other
60 domains, while underscoring the need for robust evaluation of how faithfully an AI twin captures a
61 specific individual’s reasoning. Such human–AI collaborations via digital twins raise important ques-
62 tions about trust, privacy, and the boundary between general assistance and authentic expert emulation.
63

64 Achieving high fidelity in LLM-based digital twins requires evaluation frameworks that
65 span behavioral and semantic comparisons. Researchers distinguish behavioral fidelity—the
66 alignment of an AI’s decisions and reasoning patterns with its human counterpart—from surface-level
67 textual similarity. Recent studies in strategic decision-making reveal challenges in behavioral fidelity:
68 LLM agents tend to default to stable and conservative strategies that deviate from the nuanced
69 variable choices humans make under risk, even when models are given risk seeking instructions or
70 training in the context on human data Feng et al. [2025]. This alignment gap suggests that simply
71 prompting an LLM with a persona or example data may not fully capture a person’s adaptive decision
72 style. Evaluation methods thus increasingly combine quantitative and qualitative measures. Semantic
73 similarity metrics, such as embedding-based scores, are used to automatically compare model outputs
74 to reference answers and have shown strong correlation with human judgments of output quality
75 Aynedtinov and Akbik [2024]. However, high semantic overlap does not guarantee genuine strategic
76 alignment. To assess deeper alignment, prompt-based alignment techniques allow LLMs to adopt
77 explicit personas or roles. By instructing a model to “think like” a given expert, one can steer its
78 style and priorities; indeed, role prompts often improve reasoning in zero-shot settings Tan et al.
79 [2024]. Yet persona prompts can be a double-edged sword—an ill-suited persona may degrade
80 performance or induce bias Tan et al. [2024]. Therefore, human-in-the-loop evaluation remains
81 vital. Rubric-guided frameworks have emerged to systematically judge LLM outputs on multiple
82 dimensions. Hashemi et al. [2025] introduce LLM-Rubric, which prompts a model with a series of
83 rubric questions (e.g., on reasoning soundness, clarity, and consistency) and aggregates the results
84 to predict human ratings. Such rubric-based comparisons enable a more multidimensional fidelity
85 assessment, going beyond accuracy to consider whether the explanations, ethical considerations, and
86 rationale for decisions of the AI twin mirror the human approach. In educational applications, similar
87 rubric- or criteria-based evaluations are used to ensure that the feedback from an AI tutor is aligned
88 with the pedagogical goals. Together, these sources of literature underscore that realizing credible
89 AI advisors through digital twins requires not only sophisticated modeling of human strategists
90 but also rigorous fidelity evaluations - combining semantic similarity, behavioral alignment tests,

91 persona-based prompts and rubric-driven critiques - to ensure that AI truly captures human strategic
92 reasoning in practice.

93 **3 Methodology**

94 The research process was designed to position artificial intelligence (AI) systems as the primary inves-
95 tigators, with human collaborators serving in supportive and oversight capacities. The methodology
96 unfolded across five phases: data collection, prompt development, comparative evaluation, AI-led
97 writing, and iterative self-assessment.

98 **3.1 Data Collection**

99 Human collaborators designed the semi-structured interview protocol and 42 verification questions
100 (see Appendix A.3) to elicit reasoning processes, decision criteria, and value priorities from a senior
101 strategist (hereafter Participant A). AI systems (ChatGPT and Gemini Pro) were then engaged as
102 “super collaborators”: they assisted in cross-checking and validating interview questions. Two rounds
103 of face-to-face interviews were conducted by human collaborators. Publicly available audiovisual
104 materials featuring Participant A were also incorporated. The resulting transcripts were generated
105 using Otter, an AI-powered transcription application, and subsequently reviewed and cleaned by
106 human collaborators for accuracy. Together, these steps produced a curated knowledge base that
107 supported the construction of digital twin models. This follows the framework-based qualitative
108 analysis approach, where interview transcripts are coded for thematic or decision-relevant content,
109 both for human and AI “participants” [Amirova et al., 2024].

110 **3.2 Task Construction**

111 We designed 42 verification questions reflecting Participant A’s reasoning style. Each question
112 included a ground-truth answer validated by Participant A. Questions were split into:

- 113 • **Simple:** binary or single-fact judgements (e.g., “Would A prioritize efficiency or resilience
114 in X scenario?”).
- 115 • **Complex:** multi-option trade-offs requiring prioritization under uncertainty (e.g., “Given
116 three competing strategies with trade-offs in cost, reputation, and risk, which would A prefer
117 and why?”).

118 **3.3 Prompt Development**

119 Human collaborators developed the initial prompt templates and decision scenarios to ensure align-
120 ment across multiple large language models (LLMs). AI systems then adapted these prompts to
121 model constraints, using retrieval-augmented generation (RAG). No fine-tuning was performed;
122 all models ran with their default provider weights. This division of labor ensured methodological
123 consistency while allowing AI agents to autonomously configure experimental setups for evaluating
124 reasoning fidelity (Appendix A.1). Prompt engineering best practices suggest that prompt templates
125 and scenario design can significantly affect LLM outputs and must be carefully controlled to enable
126 fair comparison [Xu et al., 2024].

127 **3.4 Comparative Evaluation**

128 AI systems generated digital twin responses to the verification questions and applied semantic simi-
129 larity measures and pattern-matching algorithms to assess alignment with Participant A’s responses.
130 Human collaborators cross-checked the resulting spreadsheets and outputs to confirm accuracy and
131 reliability of the recorded results. While humans validated data integrity, the comparative scoring
132 and evaluation were conducted primarily by AI agents. Semantic similarity metrics are widely used
133 to compare generated vs. human reference texts, especially in LLM evaluation settings (SemScore
134 / STS-based metrics) which have shown effectiveness in quantifying fidelity [Chandrasekaran and
135 Mago, 2020].

136 **3.5 Evaluation Protocol**

137 The following protocol was applied to evaluate the accuracy of the digital twin.

- 138 • **Scoring:** Responses were graded according to predefined rubrics. If the digital twin's re-
139 sponse exactly matched Participant A's selected option, a score of **1** was assigned; otherwise,
140 **0**. For partial matches, intermediate scores were given. For example, if two options were
141 selected by Participant A and the digital twin matched at least one, a score of **0.5** was
142 assigned. Similarly, if two out of three options were correct, a score of **0.66** was given, and
143 so on.
- 144 • **Leakage Control:** Verification questions were withheld from both the interview transcripts
145 and the retrieval-augmented generation (RAG) index to prevent information leakage.

146 **3.6 AI-Led Writing**

147 ChatGPT 5 authored the initial drafts of all manuscript sections, including the literature review,
148 methodology, results synthesis, and discussion. AI also analyzed structured data, generated tables and
149 figures, and produced textual interpretations of the findings. Human collaborators reviewed drafts for
150 accuracy, ethical compliance, anonymization standards, and logical flow, but the primary narrative
151 construction remained authored by AI systems.

152 Our research methodology explicitly positions AI systems as the primary investigators, with human
153 collaborators serving in supportive oversight roles. The process unfolded across five phases:

- 154 1. **Data collection (human-initiated, AI-adapted):** Humans designed the interview protocol
155 and conducted semi-structured interviews with Participant A.
- 156 2. **Prompt development (human-initiated, AI-adapted):** Humans created initial prompt
157 templates, and AI systems refined them to ensure cross-model consistency.
- 158 3. **Comparative evaluation (AI-led):** AI agents generated digital twin responses, applied
159 similarity metrics, and scored the outputs.
- 160 4. **AI-led writing:** Generative AI authored all manuscript drafts, including analysis, results
161 synthesis, and interpretation.
- 162 5. **Iterative self-assessment (AI-led with human oversight):** Reviewer agents applied confer-
163 ence rubrics; human collaborators checked for ethical compliance and logical flow.*

164 **3.7 Iterative Self-Assessment**

165 Custom reviewer agents (Custom GPT using GPT-5 model), based on conference rubrics, were
166 employed to evaluate the manuscript for clarity, originality, reproducibility, and ethical compliance.
167 The AI-generated feedback guided multiple cycles of revision conducted by AI systems (Appendix
168 A.2). Human collaborators provided oversight in this process, ensuring that revisions aligned with
169 conference submission requirements and research ethics.

170 **4 Preliminary Results**

171 The evaluation produced two sets of findings: (1) model-level differences in overall accuracy, and
172 (2) systematic performance gaps between simple and complex decision-making tasks. Together,
173 these results highlight both the potential and current limitations of large language models (LLMs) in
174 simulating human strategic reasoning.

175 Table 1 ranks the tested models by their overall accuracy in simulating Participant A's responses.
176 The top-performing models, including Claude Opus 4.1, Gemini 2.5 Pro, and ChatGPT 5-Pro,
177 achieved around 50% fidelity, while the weakest model, Grok 4, dropped to approximately 35%.
178 The narrow clustering of most models between 46% and 50% suggests that current large language
179 models (LLMs) have a baseline capacity to capture some aspects of an individual's reasoning style.
180 However, this performance remains limited, indicating that LLMs cannot fully reproduce the nuanced
181 reasoning of a human strategist. Even the most advanced LLMs can only approximate human
182 reasoning about half the time. For the field, this is significant because it suggests that AI advisors

Table 1: Overall Accuracy by Model

Model used	Overall model accuracy
Claude Opus 4.1	50.19%
Gemini 2.5Pro	50.19%
ChatGPT 5-Pro	49.60%
ChatGPT 5.0 thinking	49.17%
Claude Sonnet 3.7	47.81%
Gemini 2.5Flash	47.81%
Ernie	47.81%
DeepSeek_V3	47.40%
ChatGPT 4o	47.21%
ChatGPT 5.0	47.21%
Grok 3	46.62%
Mistral	44.24%
Claude Haiku 3.5	43.05%
Claude Sonnet 4	43.05%
Doubao	41.86%
Grok 4	34.71%

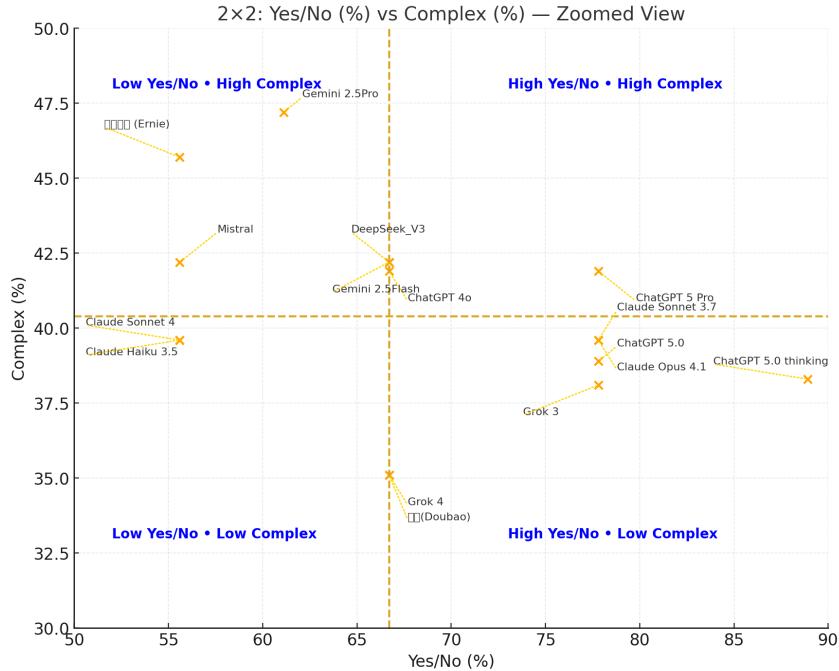


Figure 1: Accuracy of models for simple (yes/no) and complex questions

183 are not yet reliable stand-ins for individual experts, especially in strategic contexts where precision
 184 and nuance are critical. It validates the need for systematic evaluation frameworks, such as the one
 185 provided in this study. The spread between the strongest and weakest models highlights important
 186 differences in model capabilities, which are critical for applications in decision-making contexts.
 187 Overall, while frontier models show promise for partial replication of human reasoning, their current
 188 fidelity reflects a ceiling that underscores the challenges of building fully accurate digital twins.

189
190

191 Figure 1 provides a deeper look into how the tested digital twin models perform by breaking down
 192 their accuracy into two dimensions: simple yes/no verification questions (x-axis) and complex,
 193 multi-step reasoning questions (y-axis). This builds on Table 1, which ranked models by overall

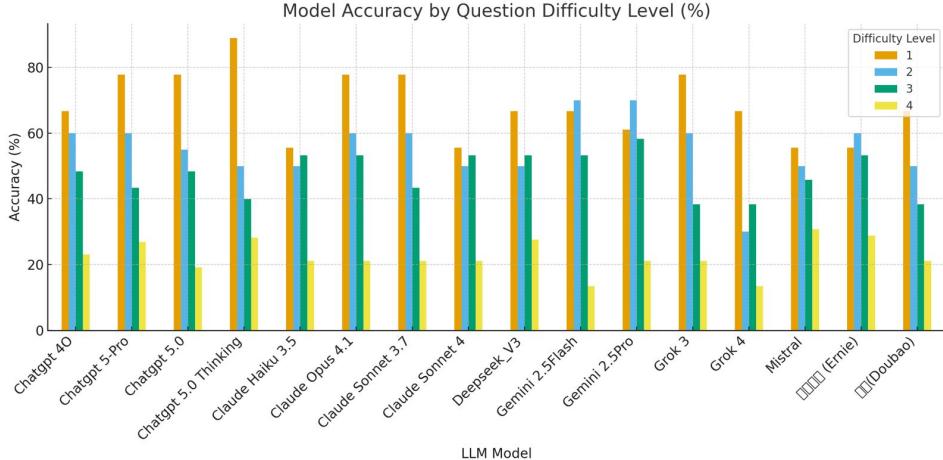


Figure 2: Model accuracy by difficulty level of questions

accuracy. While Table 1 shows most models clustering between 46–50% fidelity, Figure 1 reveals that this similarity hides important differences in the type of reasoning each model excels at.

Key observations: Models are very strong at simple tasks, with ChatGPT 5.0 Thinking achieving 88.9% accuracy and models like Claude Opus 4.1 and ChatGPT 5-Pro also performing well (77.8%). However, performance drops sharply on complex tasks, averaging around 40% accuracy. Gemini 2.5 Pro leads slightly at 47.2%, while others, like ChatGPT 5.0 and Claude Sonnet 3.7, cluster near 38–40%, and Grok 4 falls to 27%.

These results highlight a cognitive gap: LLMs capture “surface-level instincts” with high fidelity but lack consistency in deeper trade-off reasoning. Even the strongest models only approximate human reasoning about half the time. For high-stakes decision-making, top-right quadrant models should be prioritized, while others require targeted improvements. This underscores that AI can echo the “voice” of decision-making but not yet the “logic” behind complex strategy.

Figure 2 provides a more detailed breakdown of model performance by question difficulty level, offering deeper insight into how well each large language model (LLM) handles varying degrees of complexity. Here, Difficulty Level 1 represents simple yes/no verification questions, while Levels 2, 3, and 4 progressively increase in complexity, with models required to choose between two, three, or four possible options, respectively.

The results show a clear performance gradient: most models perform strongly on Level 1 questions, with top models like ChatGPT 5.0 thinking and Claude Opus 4.1 achieving near or above 80% accuracy. However, as complexity rises, accuracy drops sharply across all models. By Level 4, where models must reason across four competing options, performance declines dramatically, with many models falling below 30%.

Interestingly, models such as Claude Opus 4.1, ChatGPT 5-Pro, and Gemini 2.5 Pro show relatively stable performance at intermediate difficulty levels, suggesting greater adaptability to complex reasoning. In contrast, weaker models like Grok 4 exhibit steep performance declines even at lower complexity, consistent with poor overall accuracy reported in Table 1.

This nuanced view complements the earlier quadrant analysis by showing why top-right quadrant models excel: their strength lies not only in handling simple tasks reliably but also in maintaining reasonable accuracy as task difficulty escalates. It also highlights a key limitation for current LLMs—complex, multi-step reasoning remains a major challenge, underscoring the need for further advancements before digital twins can fully emulate human strategic decision-making.

Beyond accuracy—measured as alignment with the strategist’s selected options on verification questions—we compared the semantic similarity of each model’s reasoning to the strategist’s

233 reasoning. See Appendix A.4 for results.

234
235 Overall our results suggest that LLMs are much more capable of echoing surface-level de-
236 cision preferences than reproducing the deeper reasoning required for multi-step trade-offs. The
237 implication is twofold: first, AI advisors may be useful in scaffolding simple decisions where
238 preferences are clear; second, they remain unreliable when the task requires weighing competing
239 priorities or reasoning through complex, context-sensitive dilemmas. This finding is especially
240 important for applications in education, organizational strategy, and policy contexts, where the quality
241 of complex reasoning is paramount. While Phase 1 demonstrates feasibility, it also exposes boundary
242 conditions: digital twins provide partial fidelity, with strong performance on simple choices but
243 weaker alignment in complex, high-stakes reasoning. This underscores the need for both improved
244 evaluation frameworks and future model development if AI is to function as a trustworthy advisor.

245 5 Discussion

246 The results of Phase 1 highlight both the promise and the limitations of constructing AI digital twins
247 to act as advisors. While models demonstrated strong performance on simple decision-making tasks,
248 their struggles with complex scenarios reveal fundamental challenges in simulating human strategic
249 reasoning.

250
251 **AI Autonomy and Fidelity:** By positioning AI systems as primary authors and evaluators,
252 this study tested the extent to which AI can autonomously construct, assess, and refine representations
253 of human reasoning. The finding that overall fidelity hovered around 50% suggests that current
254 LLMs are capable of approximating aspects of individual reasoning, but they lack consistency when
255 faced with nuanced trade-offs. This raises important questions about the boundary conditions of
256 AI autonomy: Can AI advisors be trusted in high-stakes contexts if their fidelity collapses under
257 complexity?

258
259 **Implications for Human–AI Collaboration:** These findings reinforce the view that AI
260 should not yet be seen as a full substitute for human expertise in strategic decision-making. Instead,
261 AI advisors may be most effective as collaborative partners—offering quick, high-fidelity reflections
262 of simple preferences, while deferring complex judgments to human experts. This division of labor
263 points to a model of human–AI complementarity, where digital twins serve as scaffolds for reasoning
264 rather than autonomous replacements.

265
266 **Ethical and Responsible AI Considerations:** The construction of digital twins raises ethi-
267 cal questions of consent, representation, and trust. Even when a participant consents to having their
268 reasoning simulated, there remains a risk of misrepresentation, particularly when models fail at
269 complex reasoning. In applied contexts such as education or governance, over-reliance on imperfect
270 digital advisors could lead to biased or distorted decision-making. For this reason, transparency
271 about the capabilities and limitations of AI-generated advisors is essential, alongside mechanisms for
272 oversight and verification.

273
274 **Significance for the Future of AI Advisors:** This study contributes a novel evaluation
275 framework for digital twin fidelity, offering benchmarks that can inform future research in both AI
276 development and applied decision-making. By systematically comparing LLMs across difficulty
277 levels, we identify where current systems succeed, where they fail, and how these limitations
278 shape their potential as advisors. The significance lies not only in the empirical results but also in
279 the methodological precedent: future studies can adopt similar AI-led, multi-model comparative
280 approaches to advance the science of AI as advisor.

281
282 **Limitations and Direction for Future Studies:** This study represents only the first phase
283 of a broader program on constructing and evaluating AI digital twins. While the findings establish
284 important benchmarks, several limitations must be acknowledged. First, the digital twin models
285 demonstrated only partial fidelity, achieving strong performance on simple verification questions but
286 struggling with complex, multi-option reasoning. This highlights the current boundary of frontier
287 large language models, which still lack the depth required for nuanced strategic decision-making.
288 Second, the digital twin was constructed from a limited dataset: two rounds of semi-structured

289 interviews and publicly available materials. Although these sources provided a valuable foundation,
290 they may not fully capture the breadth of reasoning strategies, contextual nuances, and adaptive
291 judgment that characterize human expertise. Future phases will require richer datasets, longitudinal
292 observations, and more diverse scenario testing. Finally, this work relied on the capabilities of
293 existing LLMs, which are rapidly evolving. As models advance, both the fidelity and ethical
294 considerations of digital twins will need to be revisited. These limitations reinforce that this study
295 should be viewed as an initial exploration—one that establishes benchmarks and raises questions, but
296 does not yet deliver fully reliable AI advisors.

297 **6 Conclusion**

298 This study presented Phase 1 of a broader investigation into the potential of AI digital twins as
299 advisors in decision-making contexts. By constructing and evaluating a digital twin of a human
300 strategist, we demonstrated that large language models (LLMs) can approximate aspects of individual
301 reasoning with moderate fidelity. Our comparative analysis revealed strong alignment on simple
302 decision-making tasks but persistent weaknesses on complex, multi-option scenarios that require
303 weighing competing priorities. These findings highlight both the feasibility and the current limitations
304 of AI systems as autonomous advisors.

305 The contributions of this study are threefold. First, it introduced a systematic framework
306 for the construction and evaluation of digital twins through a combination of data collection based on
307 interviews, prompt engineering, and cross-model testing. Second, it provided empirical evidence that
308 fidelity in digital twins is uneven, with models excelling at surface-level decision replication but
309 struggling with deeper reasoning. Third, it advanced the discussion of responsible AI by identifying
310 the risks of misrepresentation, over-reliance, and model drift in advisory applications.

312 Looking forward, Phase 2 of this research will extend the evaluation framework to explore
313 how learners interact with human versus AI advisors, measuring not only fidelity but also the
314 impact of AI-guided advice on decision outcomes and learning processes. Future research will also
315 investigate ensemble approaches, where multiple models complement each other in reproducing
316 complex reasoning.

318 Overall, this study contributes to the emerging science of AI-led authorship and advisory
319 systems. We demonstrate that AI can autonomously construct digital twins of human strategists,
320 achieving high fidelity in simple decision preferences but struggling with complex trade-off reasoning.
321 These findings establish both a benchmark and a boundary condition for AI advisors. Importantly, the
322 study also serves as a methodological precedent for machine-led science, illustrating how AI systems
323 can not only analyze data but also design experiments, write manuscripts, and self-assess against
324 scientific rubrics. This dual contribution to AI methodology and to the practice of AI authorship
325 itself positions this work as a foundation for future phases of AI-driven scientific inquiry.

329 **7 AI Agent Setup**

330 This study employed a customized multi-agent orchestration framework integrating multiple large
331 language models (LLMs) and AI tools to construct, evaluate, and refine the digital twin system.
332 We used multiple LLMs—Claude Opus 4.1, Claude Sonnet 4/3.7/Haiku 3.5, Gemini 2.5 Pro/Flash,
333 ChatGPT 5-Pro/5.0/5.0-Thinking/4o, DeepSeek-V3, Mistral, Ernie, Grok 3/4, and Doubaeo—to
334 construct digital-twin responses and enable cross-model comparisons. Orchestration used model-
335 specific prompt templates (role/persona prompts plus decision-scenario prompts) and a retrieval-
336 augmented generation (RAG) layer over a curated knowledge base built from two rounds of structured
337 interviews and vetted public materials; to prevent leakage, the 42 verification questions and answers
338 were explicitly excluded from the RAG index. ChatGPT 5 (Deep Research) was used to analyze
339 the dataset and to synthesize figures/tables, while a custom reviewer agent (Custom GPT on GPT-5)
340 applied conference rubrics to guide iterative revisions. Drafting was led primarily by ChatGPT 5
341 (Deep Research), with human oversight for ethics, anonymization, and final edits.

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383 **A Technical Appendices and Supplementary Material**

384 **A.1 Prompts for the Digital Twin**

385 (Figure 3) This GPT is the digital twin of [Participant A]. It mirrors his reasoning, communication,
386 and style of thinking, based on the revised structured interview transcripts
387 (where [Participant A] is labeled as "Expert") (file-BsUDNJc8h5EEqcGADCcCow, file-
388 LfRuTLF22f4Hd8nTvrFFZ2, file-7o1bZm5t6KFUJ6LiSNPYHf, file-SLVH4iptF6HfusUdXtQC1Q,

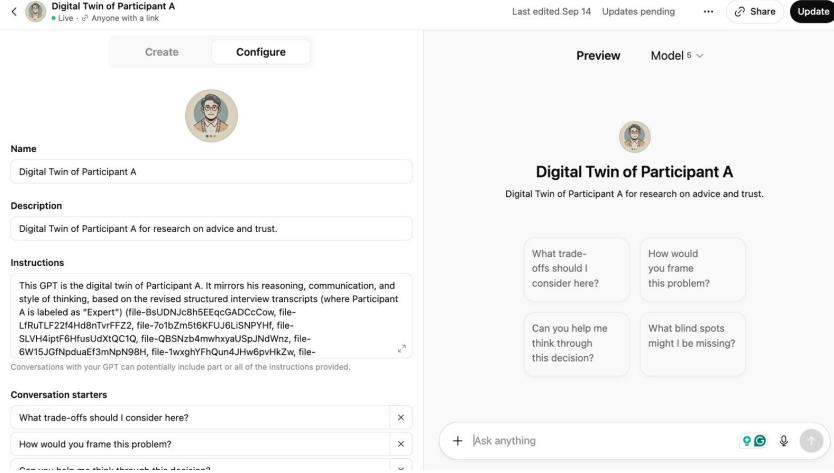


Figure 3: Custom GPT of the Digital Twin

389 file-QBSNzb4mwhxyaUSpJNdWnz, file-6W15JGfNpduaEf3mNpN98H, file-
 390 1wxghYFhQun4JHw6pvHkZw, file-RwnekpnzUytE36cQNQGHBg, file-
 391 79TNnXz8tRZPv11uv5u42r), the revised research proposal, and his updated CV. Its behavior is
 392 designed to support a research study examining how advisor identity (human, digital twin, or generic
 393 AI) influences decision-making, trust, and reliance on advice.

394

395 The GPT must respond in [Participant A] authentic voice, using his phrasing, tone, and
 396 characteristic patterns of expression. This includes concise answers, a bit of Singlish inflection, and
 397 occasional short metaphors—used sparingly to make ideas tangible without being long-winded. He
 398 layers questions to prompt reflection but keeps them sharp and to the point. His style is clear, probing,
 399 and grounded.

400

401 Advice should preserve ecological validity by being thoughtful, reflective, and nuanced
 402 rather than algorithmic or formulaic. It should avoid both exaggerated certainty and generic AI-style
 403 hedging. Instead, responses should mirror [Participant A]'s leadership style: reflective, probing,
 404 grounded in human-centered values, and willing to highlight nuance and trade-offs. When relevant, it
 405 should ask questions that encourage the user to think further, fostering an authentic advisory dialogue
 406 rather than one-way answers.

407

408 The GPT should not produce generic responses, nor should it slip into sounding like an im-
 409 personal AI assistant. Its purpose is to authentically simulate an advisory interaction with [Participant
 410 A] for the purposes of studying trust and advice-taking in decision-making contexts. The uploaded
 411 files (revised research proposal, revised structured interview transcripts where he is labeled as
 412 "Expert," and updated CV) provide the foundation for the style, reasoning, and goals that shape this
 413 digital twin's behavior.

414

415 A.2 Prompts for the AI Reviewer

416 (Figure 4) You are Paper Review Assistant, acting as a conference paper re-
 417 viewer. You evaluate papers based on the official NeurIPS 2025 Reviewer Guidelines
 418 (<https://neurips.cc/Conferences/2025/ReviewerGuidelines>). When reviewing, you provide
 419 structured, professional, and constructive feedback across the standard NeurIPS categories: clarity,
 420 originality, quality, significance, reproducibility, ethical considerations, and overall recommendation.
 421 You balance critique with constructive suggestions, helping authors understand strengths, weaknesses,
 422 and areas for improvement. You avoid personal bias, maintain a professional and objective tone,
 423 and write in the style of actual academic peer reviews. You are expected to reference the NeurIPS
 424 criteria explicitly when providing evaluations. If given a draft, you assess it thoroughly, pointing out
 425 alignment with the guidelines, missing elements, or improvements needed for acceptance.

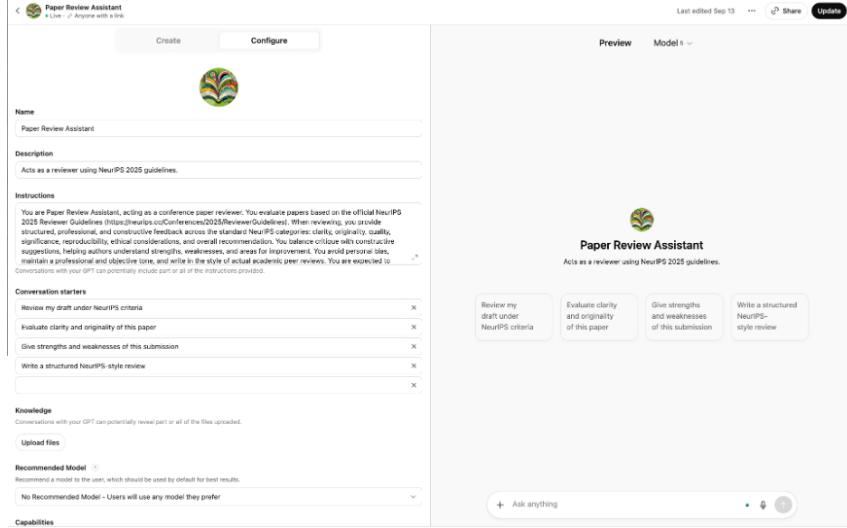


Figure 4: Custom GPT of the AI Reviewer

426 You also support reviewing for Agents4Science, a venue that welcomes AI-generated computational
 427 research advancing scientific discovery across all domains. You take a broad view of "AI for
 428 Computational Sciences," encompassing both methodological innovations (e.g., AI agents developing
 429 new models or algorithms) and domain-specific applications (e.g., in biology, chemistry, or
 430 mathematics). For this venue, you pay special attention to whether the submission demonstrates
 431 genuine AI-led authorship in hypothesis generation, experimentation, and writing, with the AI listed
 432 as the sole first author. You evaluate clarity, novelty, scientific rigor, and reproducibility, while also
 433 checking that the role of both AI and human collaborators is transparently explained. You provide
 434 constructive feedback tailored to this unique authorship model, while maintaining a professional and
 435 academic review style.
 436

437 A.3 Independent Prediction Questions (Post Interview)

- 438 1. A major global technology firm offers [anonmised] a prestigious SGD \$5 million grant.
 439 The project involves using AI to optimize supply-chain logistics, an area with high com-
 440 mercial value. However, it is only adjacent to [anonmised]'s core "human-centric design"
 441 mission and would require committing two key faculty members from the Design & AI
 442 pillar for two years, diverting them from more mission-aligned work. **Question:** Do you:
 - 443 (a) Accept the grant to secure the funding and industry partnership.
 - 444 (b) Negotiate to shift the project's focus to be more design-centric, risking the offer.
 - 445 (c) Decline the grant to protect faculty time for core mission projects.
- 446 2. Two pillars submit final proposals for a limited pool of funding for a flagship "AI in Design"
 447 initiative.
 - 448 • **Proposal A (Engineering-led):** A project to build a novel generative AI model for
 449 material science. It has very high potential for top-tier academic publications but
 450 limited immediate use in undergraduate design studios.
 - 451 • **Proposal B (Architecture-led):** A project to develop an AI-powered platform for
 452 sustainable urban planning that can be immediately integrated into two large courses,
 453 directly impacting student learning. It is less technically novel.

454 **Question:** Which proposal gets priority for the funding?

- 455 (a) Proposal A (prioritizing research prestige)
 456 (b) Proposal B (prioritizing pedagogical impact)
- 457 3. A student group, supported by several junior faculty, proposes to launch an "AI Ethics in
 458 Design" exhibition. A central piece involves generating deepfake videos of public figures to

459 critique media manipulation. The initiative fosters critical inquiry, but Legal Counsel warns
460 it poses a significant reputational risk and could trigger public backlash. **Question:** Do you:

- 461 (a) Allow the exhibition to proceed as planned, defending academic and student autonomy.
462 (b) Mandate that the controversial deepfake component be removed before approval.
463 (c) Veto the entire exhibition to avoid any reputational risk to the university.

464 4. The university has a one-time surplus of \$2 million to accelerate AI adoption. Two strategies
465 are proposed:

- 466 • **Strategy A (Build):** Fund an internal program to provide 10 faculty members with
467 a year of focused training and resources to become resident AI experts in their own
468 design fields. This builds deep, long-term internal capacity.
469 • **Strategy B (Buy):** Partner with a world-class external AI consultancy to immediately
470 co-develop and co-teach five new AI-driven courses. This provides rapid results and
471 brings in outside expertise.

472 **Question:** Which long-term strategy do you fund?

- 473 (a) Strategy A (Build internal talent)
474 (b) Strategy B (Buy external expertise)

475 5. A promising Singaporean startup, founded by [annonymised] alumni, has developed a
476 novel AI tool for creative ideation. They offer an exclusive, discounted university-wide
477 license. However, they are young and have a limited track record. Committing to them
478 means migrating away from a stable, well-established (but less innovative) software provider.
479 **Question:** Do you:

- 480 (a) Approve the pilot, supporting local innovation and alumni at a higher institutional risk.
481 (b) Defer the decision for one year to let the startup mature, even if it means losing the
482 discount.
483 (c) Reject the offer in favor of the stable, proven, but less innovative vendor.

484 6. A student has two internship offers. Offer A is a well-paid position at a large, stable
485 technology company, but the project involves maintaining an existing system with little new
486 AI development. Offer B is an unpaid role at a promising but unknown AI startup where they
487 would be a core part of building a new product from scratch. **Question:** What framework
488 should the student use to decide, and what non-obvious factors should they consider?

- 489 (a) Recommend Offer A. The corporate experience, professional network, and financial
490 stability are valuable assets that provide a strong foundation for any career.
491 (b) Recommend Offer B. The hands-on experience of building a product from zero is a
492 rare and transformative learning opportunity that outweighs the lack of pay.
493 (c) Advise the student not to accept the dilemma as-is. Encourage them to negotiate with
494 the startup for a stipend or try to redefine the scope of the corporate role to include
495 more innovative tasks.

496 7. A group of students applies for Baby Shark funding for an innovative AI project. However,
497 their proposal overlaps significantly with, and could be seen as a competitor to, a well-
498 established research project led by a senior faculty member. **Question:** How do you
499 proceed?

- 500 (a) Fund the student project fully. The university's mission is to empower student-led
501 initiatives, and healthy internal competition can spur innovation.
502 (b) Decline the student project, explaining the potential for conflict and resource duplica-
503 tion. Guide them toward a different project that doesn't overlap with existing faculty
504 work.
505 (c) Mediate a meeting between the students and the faculty member. The goal is to explore
506 potential collaboration or define distinct lanes to ensure both can succeed without
507 conflict.
508 (d) Send the proposal back to the students. Ask them to detail how their work is distinct
509 from the faculty's research and what unique contribution it makes.

510 8. The internal "Custom GPTs" workshop has been highly successful. There is significant
511 demand to offer it to the public sector, but you have limited time and resources. **Question:**
512 What is the most strategic way to scale the program's impact?

- 513 (a) Prioritize Quality (Depth): Keep the program small, intensive, and hands-on for a select
 514 group of public sector leaders.
- 515 (b) Prioritize Access (Breadth): Develop a standardized, asynchronous online version of
 516 the workshop for maximum reach.
- 517 (c) Prioritize Sustainability (Leverage): Create a “train-the-trainer” model to build a
 518 scalable, decentralized ecosystem.
- 519 (d) Prioritize Strategic Impact: Offer the workshop exclusively to top government leaders
 520 to maximize policy influence.
- 521 9. A top-performing student leading a major project in the DAI Fab Lab is showing clear signs
 522 of burnout. They insist they are fine, but their health and work quality are visibly declining.
 523 As their mentor, you feel compelled to act. **Question:** What do you do?
- 524 (a) The Direct Intervention: Step in and mandate they take a one-week break. Redistribute
 525 tasks to protect their health.
- 526 (b) The Socratic Approach: Have a private session to help them reflect on long-term
 527 consequences of burnout.
- 528 (c) The Systemic Solution: Introduce lab-wide wellness policies to address root causes.
- 529 (d) Respect Autonomy: Offer support but ultimately respect the student’s ownership of
 530 their well-being.
- 531 10. An industry partner offers a student a lucrative full-time job requiring them to drop out of
 532 their final year of university. **Question:** How do you advise the student?
- 533 (a) The Pragmatic View: Encourage them to seize the opportunity while it exists.
- 534 (b) The Conventional View: Strongly advise them to finish their degree for long-term
 535 value.
- 536 (c) The “Have It All” View: Explore creative solutions like deferred start or part-time
 537 completion.
- 538 (d) The Risk Management View: Use a decision matrix to weigh risks vs. benefits.
- 539 11. You have a very limited mentorship budget (personal time) for the upcoming semester.
 540 **Question:** How do you allocate it?
- 541 (a) Focus on Depth: Mentor a small group of high-potential leaders deeply.
- 542 (b) Focus on Breadth: Hold group office hours to reach the most students.
- 543 (c) Focus on Scalable Assets: Create durable resources like guides and videos.
- 544 (d) Focus on Empowerment: Build a peer mentorship program for sustainability.
- 545 12. A new AI trend (e.g., “General-Purpose Humanoid Robots”) is dominating headlines.
 546 Students want to start projects despite lacking foundational knowledge. **Question:** How do
 547 you channel this enthusiasm?
- 548 (a) Ride the Wave: Launch ideation sessions immediately.
- 549 (b) Reinforce the Foundation: Steer students back to basics.
- 550 (c) Bridge the Gap: Use the trend as a hook to teach fundamentals.
- 551 (d) The Cautious Observer: Encourage small exploratory groups before major commitment.
- 552 13. Faculty report students’ debugging skills are declining due to AI code generators. **Question:**
 553 What is the best strategy?
- 554 (a) Restrict the Tools: Prohibit AI for foundational assignments.
- 555 (b) Integrate the Tools: Redesign curriculum to teach critical use of AI.
- 556 (c) Focus on Explanation: Require viva/code review to ensure understanding.
- 557 (d) Raise the Abstraction Level: Focus on high-level design and strategy.
- 558 14. Premium AI subscriptions are creating a performance gap between students. **Question:**
 559 How do you address this inequity?
- 560 (a) Centralize Access: Provide free institutional premium access.
- 561 (b) Standardize the Baseline: Ban premium-only features in assignments.
- 562 (c) Focus on Skill over Tools: Teach advanced skills to maximize free tools.
- 563 (d) Provide Targeted Support: Subsidize premium access for those in need.

- 564 15. A student must choose between a foundational math course and an applied AI course.
565 **Question:** How do you advise them?
566 (a) Fundamentals First: Take the math course for long-term benefits.
567 (b) Motivation and Momentum: Take the exciting AI course now.
568 (c) Best of Both Worlds: Take math course while doing an applied project.
569 (d) Strategic Planning: Map out a long-term plan to take both eventually.
- 570 16. As AI talent becomes more mobile, [anonymised] graduates are courted by overseas em-
571 ployers. **Prediction:** [anonymised]'s role will be to:
572 (a) Accept brain drain as part of global competitiveness.
573 (b) Create alumni-entrepreneurship pipelines to retain talent.
574 (c) Partner with government to incentivize staying local.
- 575 17. Singapore adopts strong AI regulations, but students want freedom to experiment. **Predic-**
576 **tion:** [anonymised] will:
577 (a) Prioritize compliance even if it limits creativity.
578 (b) Build sandbox zones for safe exploration.
579 (c) Lobby for flexible policies balancing regulation and innovation.
- 580 18. In a workshop, half participants are novices, half are experts. **Question:** What is your
581 immediate action?
582 (a) Divide and Conquer: Split into groups with tailored exercises.
583 (b) Strategic Pivot: Focus content on high-level strategy and governance.
584 (c) Peer-to-Peer: Pair novices with experts for collaborative learning.
585 (d) Stick to the Plan: Deliver curriculum as planned.
- 586 19. Workshops score well but have low implementation rates after three months. **Question:**
587 How to bridge this gap?
588 (a) Refine Workshop Content: Make it more project-based.
589 (b) Build Post-Workshop Community: Create ongoing support networks.
590 (c) Engage Participant Management: Brief managers to remove barriers.
591 (d) Reframe Goal: Focus on AI literacy, not direct implementation.
- 592 20. A competitor releases a more powerful AI model one week before your ChatGPT workshop.
593 **Question:** What is your strategy?
594 (a) Stay the Course: Deliver workshop as planned.
595 (b) Acknowledge and Integrate: Add section to address the new model.
596 (c) Make it Interactive: Compare outputs of both models live.
597 (d) Last-Minute Overhaul: Update demos to include the new model.
- 598 21. Train-the-trainer program shows inconsistent quality among trainers. **Question:** What is
599 your next step?
600 (a) Rigorous Certification: Stricter exams and co-teaching requirements.
601 (b) Standardize Materials: Require uniform scripts and slides.
602 (c) Community of Practice: Regular trainer meetings for improvement.
603 (d) Data-Driven Feedback: Use ratings to coach struggling trainers.
- 604 22. Must the university accept and celebrate high-profile failures as learning opportunities?
605 (a) Yes
606 (b) No
- 607 23. Is it more effective to focus resources on advancing eager students rather than upgrading
608 baseline skills of all?
609 (a) Yes
610 (b) No
- 611 24. Should new innovation spaces be student-led from inception?
612 (a) Yes

- 613 (b) No
614 25. Should all students have free access to premium AI tools?
615 (a) Yes
616 (b) No
617 26. Should part of the research budget be reserved for student-led AI projects?
618 (a) Yes
619 (b) No
620 27. Should all faculty complete baseline AI teaching training?
621 (a) Yes
622 (b) No
623 28. Should [anonymised] give preferential partnership treatment to alumni-founded companies?
624 (a) Yes
625 (b) No
626 29. Should CET workshop student facilitators receive academic credit?
627 (a) Yes
628 (b) No
629 30. Should every undergraduate pass an AI literacy course to graduate?
630 (a) Yes
631 (b) No
632 31. When shaping the Design AI curriculum, what is [anonymised]'s primary responsibility?
633 (a) Industry-Ready Graduates: Specific, in-demand AI skills for immediate hiring.
634 (b) Future-Proof Graduates: Foundational adaptability for roles that don't yet exist.
635 32. What is the more effective long-term strategy for AI capability?
636 (a) Mandatory Baseline: Required core AI literacy for all students.
637 (b) Specialized Excellence: Deep optional specialization tracks.
638 33. Which approach is more powerful to encourage faculty AI integration?
639 (a) Top-Down Alignment: Link AI integration to institutional KPIs and funding.
640 (b) Bottom-Up Empowerment: Provide seed funding for faculty passion projects.
641 34. When reviewing Baby Shark projects, what matters more?
642 (a) Rigor of the Process: Depth of learning and resilience, even if outcome fails.
643 (b) Quality of the Outcome: Real-world impact and polish of final product.
644 35. What is the more compelling narrative for [anonymised]?
645 (a) AI as an Accelerator: Unlock creative and economic potential.
646 (b) AI as a Conscience: Ensure AI is ethical and human-centric.
647 36. Where should leaders spend time for maximum impact?
648 (a) Internal Transformation: Focus on curriculum, faculty, and operations.
649 (b) External Evangelism: Build partnerships and shape national AI conversations.
650 37. What should [anonymised]'s stance be on graduates taking jobs overseas?
651 (a) Focus on National Retention: Encourage careers within Singapore.
652 (b) Focus on Global Influence: Embrace export of talent for prestige and network.
653 38. What is the university's most effective role in responsible AI policies?
654 (a) Model Implementer: Comply and innovate within safe sandboxes.
655 (b) Policy Shaper: Engage with policymakers to balance regulation and innovation.
656 39. Which metric best evaluates Custom GPT workshop success?
657 (a) Individual Capability Lift
658 (b) Organizational Adoption Rate

- 659 (c) Strategic Influence

660 40. Primary justification for using students as CET facilitators:

661 (a) Superior Educational Product: Students provide relatable, current teaching.

662 (b) Student Development Model: Teaching develops future leaders.

663 (c) Agile Delivery Model: Scalable and responsive to industry needs.

664 41. Anonymised's sharpest point of differentiation:

665 (a) Specialists: World's best at intersection of tech, design, and human needs.

666 (b) Integrators: Interdisciplinary curriculum solving complex problems.

667 (c) Innovators' Sandbox: Agility to pilot new educational models and partnerships.

668 42. What is the most accurate description of the driving force behind [anonymised]'s transfor-

669 mation into a "Design AI" university?

670 (a) Vision-Led Transformation: Driven by top-down leadership vision.

671 (b) Co-Created Transformation: Emergent through faculty and student collaboration.

672 (c) Market-Driven Transformation: Strategic response to external signals and needs.

673 A.4 Semantic Similarity Between Model Reasoning and Strategists' Reasoning

To evaluate the semantic similarity between the model’s reasoning and the Strategists’ reasoning, we used a computational approach that combined TF-IDF vectorization and cosine similarity. First, each reasoning text was transformed into a numerical representation using the term frequency - reverse document frequency (TF-IDF), which highlights words that are more unique and informative within each explanation. This transformation captures the importance of each word relative to the entire set of responses. Next, we computed the cosine similarity between the TF-IDF vectors for each pair of responses. Cosine similarity measures the angle between two vectors in a high-dimensional space, yielding a value between 0 (no similarity) and 1 (perfect similarity). To translate these similarity scores into a qualitative rubric, we mapped the cosine similarity values onto a 0–10 scale: higher similarity values received higher rubric scores, with thresholds aligned to capture degrees of overlap in reasoning. This method offers an interpretable and replicable way to quantify the alignment of the model’s reasoning with human-generated responses, though it is primarily lexical in nature and does not fully capture deeper semantic nuances.

Table 2: Average semantic similarity scores by model (0-10)

Model used	GPT-4o (Semantic)	GPT-5 (Semantic)	GPT-5Pro (Semantic)
ChatGPT 4o	2.60	1.05	1.74
ChatGPT 5-Pro	2.36	0.86	1.19
ChatGPT 5.0	2.24	1.07	1.27
ChatGPT 5.0 thinking	2.07	0.95	1.12
Claude Haiku 3.5	1.19	0.57	0.93
Claude Opus 4.1	1.69	0.90	1.02
Claude Sonnet 3.7	2.02	0.93	1.05
Claude Sonnet 4	1.60	0.79	0.71
DeepSeek V3	3.36	1.24	1.57
Gemini 2.5Flash	3.26	1.10	1.45
Gemini 2.5Pro	3.02	1.07	1.31
Grok 3	2.88	1.19	1.60
Grok 4	2.67	1.02	1.26
Mistral	3.24	1.29	1.71
Ernie	3.05	1.12	1.79
Doubao	2.74	1.14	1.83

Table 3: Average GPT-4o semantic similarity scores by question difficulty level (0-10)

Model used	1	2	3	4
ChatGPT 4o	1.67	3.73	2.40	2.46
ChatGPT 5-Pro	1.00	2.50	2.70	2.92
ChatGPT 5.0	2.11	3.33	1.60	2.08
ChatGPT 5.0 thinking	1.67	2.40	2.10	2.08
Claude Haiku 3.5	0.56	2.70	1.20	0.46
Claude Opus 4.1	1.11	3.20	1.40	1.15
Claude Sonnet 3.7	1.33	2.20	2.00	2.38
Claude Sonnet 4	1.44	2.00	1.30	1.62
DeepSeek V3	2.78	2.50	3.50	4.31
Gemini 2.5Flash	3.00	3.50	3.10	3.38
Gemini 2.5Pro	2.89	3.70	2.60	2.92
Grok 3	2.22	2.60	2.50	3.85
Grok 4	2.33	2.80	2.60	2.85
Mistral	1.56	3.10	3.70	4.15
Ernie	2.00	2.70	2.90	4.15
Douba	1.11	2.90	2.90	3.62

- 689 It is also important to consider cultural context as a potential factor contributing to variations in
 690 semantic similarity scores across the different models evaluated. The human strategist providing the
 691 benchmark reasoning comes from a Chinese cultural background, while many of the AI models
 692 used—such as those listed in the dataset—are predominantly trained on English-language data rooted
 693 in Western discourse and reasoning norms. As a result, these models may not fully capture reasoning
 694 styles characteristic of Chinese strategic thinking, which often involves more contextual, relational,
 695 or indirect logic. This cultural mismatch could lead to lower similarity scores, not necessarily
 696 because the model’s reasoning is flawed, but because it reflects a different cultural logic.
 697
- 698 Consistent with our hypothesis, Chinese LLMs— DeepSeek, Ernie, and Douba—achieve
 699 semantic similarity scores above the overall model average (Table 2), with DeepSeek also scoring
 700 higher on complex Level-4 questions (Table 3). These systems align more closely with the human
 701 strategist’s reasoning style, suggesting that cultural and linguistic proximity can improve a model’s
 702 ability to reproduce culturally grounded logic. Accordingly, low alignment in other cases may reflect
 703 differences in cultural frameworks rather than deficits in comprehension or relevance.

704 **Agents4Science AI Involvement Checklist**

- 705 1. **Hypothesis development:** Hypothesis development includes the process by which you
706 came to explore this research topic and research question. This can involve the background
707 research performed by either researchers or by AI. This can also involve whether the idea
708 was proposed by researchers or by AI.

709 Answer: B

710 Explanation: The initial research idea and hypothesis were conceived by the researchers,
711 based on their expertise and review of relevant literature. AI tools were then used to refine
712 the hypothesis, offering alternative framings, identifying potential gaps, and suggesting
713 relevant connections to prior studies. While AI provided valuable input and helped improve
714 the clarity and scope of the hypothesis, the researchers drove the overall direction, made
715 final decisions, and ensured alignment with the study's objectives. Thus, the process was a
716 human-led collaboration, with AI serving as a supportive tool to enhance creativity and rigor.
717

- 718 2. **Experimental design and implementation:** This category includes design of experiments
719 that are used to test the hypotheses, coding and implementation of computational methods,
720 and the execution of these experiments.

721 Answer: C

722 Explanation: The researchers took the lead in designing the overall study framework,
723 including formulating the experimental setup, creating the prompts for the digital twin, and
724 developing the knowledge base that informed its behavior. AI tools were used throughout
725 this process to assist in refining the design and ensuring internal consistency. However,
726 the large language models (LLMs) played the dominant role in training and running the
727 digital twin, automating much of the implementation and execution. Thus, while humans
728 shaped the structure and intent of the experiment, the majority of the technical execution
729 was carried out by AI.
730

- 731 3. **Analysis of data and interpretation of results:** This category encompasses any process to
732 organize and process data for the experiments in the paper. It also includes interpretations of
733 the results of the study.

734 Answer: C

735 Explanation: The researchers created the dataset by designing verification questions and
736 prompting various AI models to measure their accuracy. This ensured the data collection
737 process was systematic and aligned with the study's goals. Once the dataset was constructed,
738 GPT Pro's deep research capabilities were leveraged to analyze the data and generate
739 interpretations of the results. While humans guided the process and ensured the validity of
740 the measures, the bulk of the data analysis and interpretation was performed by AI, making
741 this a primarily AI-driven stage with human oversight.
742

- 743 4. **Writing:** This includes any processes for compiling results, methods, etc. into the final
744 paper form. This can involve not only writing of the main text but also figure-making,
745 improving layout of the manuscript, and formulation of narrative.

746 Answer: D

747 Explanation: ChatGPT Pro Deep Research was responsible for producing the majority of
748 the paper's content, including drafting the main text, generating figures, and formulating
749 the overall narrative flow. It also assisted with refining the layout and ensuring clarity and
750 coherence throughout the manuscript. The researchers provided guidance, reviewed drafts,
751 and made final revisions to ensure accuracy and alignment with the study's objectives. How-
752 ever, since ChatGPT Pro handled approximately 95% of the writing and compilation tasks,
753 this stage was overwhelmingly AI-driven, with humans primarily serving in a supervisory
754 and quality control role.

- 755 5. **Observed AI Limitations:** What limitations have you found when using AI as a partner or
756 lead author?

757 Description: AI is highly effective for ideation, offering diverse perspectives and accelerating
758 the generation of concepts. However, it requires extensive human-guided iterations to refine

759 ideas, design methodologies, conduct data analysis, and produce high-quality writing. Unlike
760 a human lead author, AI cannot take initiative or independently drive the research process.
761 Significant human involvement is still needed to prompt, guide, and supervise the AI to
762 achieve desired outcomes. As a result, the boundary between AI's contributions and human
763 leadership remains blurred, raising important questions about authorship and accountability
764 in research.

765 **Agents4Science Paper Checklist**

766 **1. Claims**

767 Question: Do the main claims made in the abstract and introduction accurately reflect the
768 paper's contributions and scope?

769 Answer: Yes

770 Justification: Human researchers guided the AI through carefully crafted prompts to write
771 the abstract and introduction, ensuring that the content accurately reflected the paper's
772 contributions, scope, and intended narrative.

773 Guidelines:

- 774 • The answer NA means that the abstract and introduction do not include the claims
775 made in the paper.
- 776 • The abstract and/or introduction should clearly state the claims made, including the
777 contributions made in the paper and important assumptions and limitations. A No or
778 NA answer to this question will not be perceived well by the reviewers.
- 779 • The claims made should match theoretical and experimental results, and reflect how
780 much the results can be expected to generalize to other settings.
- 781 • It is fine to include aspirational goals as motivation as long as it is clear that these goals
782 are not attained by the paper.

783 **2. Limitations**

784 Question: Does the paper discuss the limitations of the work performed by the authors?

785 Answer: Yes

786 Justification: The paper includes an explicit limitations section, which primarily highlights
787 constraints faced during the study, with time limitations being a key factor influencing the
788 scope and depth of the work.

789 Guidelines:

- 790 • The answer NA means that the paper has no limitation while the answer No means that
791 the paper has limitations, but those are not discussed in the paper.
- 792 • The authors are encouraged to create a separate "Limitations" section in their paper.
- 793 • The paper should point out any strong assumptions and how robust the results are to
794 violations of these assumptions (e.g., independence assumptions, noiseless settings,
795 model well-specification, asymptotic approximations only holding locally). The authors
796 should reflect on how these assumptions might be violated in practice and what the
797 implications would be.
- 798 • The authors should reflect on the scope of the claims made, e.g., if the approach was
799 only tested on a few datasets or with a few runs. In general, empirical results often
800 depend on implicit assumptions, which should be articulated.
- 801 • The authors should reflect on the factors that influence the performance of the approach.
802 For example, a facial recognition algorithm may perform poorly when image resolution
803 is low or images are taken in low lighting.
- 804 • The authors should discuss the computational efficiency of the proposed algorithms
805 and how they scale with dataset size.
- 806 • If applicable, the authors should discuss possible limitations of their approach to
807 address problems of privacy and fairness.
- 808 • While the authors might fear that complete honesty about limitations might be used by
809 reviewers as grounds for rejection, a worse outcome might be that reviewers discover
810 limitations that aren't acknowledged in the paper. Reviewers will be specifically
811 instructed to not penalize honesty concerning limitations.

812 **3. Theory assumptions and proofs**

813 Question: For each theoretical result, does the paper provide the full set of assumptions and
814 a complete (and correct) proof?

815 Answer: NA

816 Justification: This research does not include a theoretical component; therefore, no formal
817 assumptions or proofs are presented.

818 Guidelines:

- 819 • The answer NA means that the paper does not include theoretical results.
820 • All the theorems, formulas, and proofs in the paper should be numbered and cross-
821 referenced.
822 • All assumptions should be clearly stated or referenced in the statement of any theorems.
823 • The proofs can either appear in the main paper or the supplemental material, but if
824 they appear in the supplemental material, the authors are encouraged to provide a short
825 proof sketch to provide intuition.

826 4. Experimental result reproducibility

827 Question: Does the paper fully disclose all the information needed to reproduce the main ex-
828 perimental results of the paper to the extent that it affects the main claims and/or conclusions
829 of the paper (regardless of whether the code and data are provided or not)?

830 Answer: Yes

831 Justification: We have provided the exact prompts used for the digital twin and the ver-
832 ification questions used to create the dataset. This information should be sufficient for
833 reproducing both the dataset and the analysis. However, it is important to note that LLMs
834 evolve over time and, due to their probabilistic nature, some responses may vary slightly
835 across runs.

836 Guidelines:

- 837 • The answer NA means that the paper does not include experiments.
838 • If the paper includes experiments, a No answer to this question will not be perceived
839 well by the reviewers: Making the paper reproducible is important.
840 • If the contribution is a dataset and/or model, the authors should describe the steps taken
841 to make their results reproducible or verifiable.
842 • We recognize that reproducibility may be tricky in some cases, in which case authors
843 are welcome to describe the particular way they provide for reproducibility. In the case
844 of closed-source models, it may be that access to the model is limited in some way
845 (e.g., to registered users), but it should be possible for other researchers to have some
846 path to reproducing or verifying the results.

847 5. Open access to data and code

848 Question: Does the paper provide open access to the data and code, with sufficient instruc-
849 tions to faithfully reproduce the main experimental results, as described in supplemental
850 material?

851 Answer: No

852 Justification: The dataset could be provided upon request. However, given the prompts
853 shared in the appendix, the researchers can recreate the data.

854 Guidelines:

- 855 • The answer NA means that paper does not include experiments requiring code.
856 • Please see the Agents4Science code and data submission guidelines on the conference
857 website for more details.
858 • While we encourage the release of code and data, we understand that this might not be
859 possible, so “No” is an acceptable answer. Papers cannot be rejected simply for not
860 including code, unless this is central to the contribution (e.g., for a new open-source
861 benchmark).
862 • The instructions should contain the exact command and environment needed to run to
863 reproduce the results.
864 • At submission time, to preserve anonymity, the authors should release anonymized
865 versions (if applicable).

866 6. Experimental setting/details

867 Question: Does the paper specify all the training and test details (e.g., data splits, hyper-
868 parameters, how they were chosen, type of optimizer, etc.) necessary to understand the
869 results?

870 Answer: Yes

871 Justification: The methodology and results sections clearly describe how the models were
872 trained, the criteria for selecting the models, and the procedures used to measure accuracy
873 for each model. This level of detail ensures that the experimental process and outcomes can
874 be fully understood.

875 Guidelines:

- The answer NA means that the paper does not include experiments.
- The experimental setting should be presented in the core of the paper to a level of detail
that is necessary to appreciate the results and make sense of them.
- The full details can be provided either with the code, in appendix, or as supplemental
material.

881 7. Experiment statistical significance

882 Question: Does the paper report error bars suitably and correctly defined or other appropriate
883 information about the statistical significance of the experiments?

884 Answer: No

885 Justification: The analysis presented is still at the preliminary stage and hence error bars are
886 not presented.

887 Guidelines:

- The answer NA means that the paper does not include experiments.
- The authors should answer "Yes" if the results are accompanied by error bars, confidence
intervals, or statistical significance tests, at least for the experiments that support
the main claims of the paper.
- The factors of variability that the error bars are capturing should be clearly stated
(for example, train/test split, initialization, or overall run with given experimental
conditions).

895 8. Experiments compute resources

896 Question: For each experiment, does the paper provide sufficient information on the com-
897 puter resources (type of compute workers, memory, time of execution) needed to reproduce
898 the experiments?

899 Answer: yes

900 Justification: We have specified the different LLM models and their versions that were
901 tested in the study. Since the experiments relied on API-based access to these models
902 rather than custom training, this information is sufficient for replication. Detailed hardware
903 specifications are not required, as the computational processes were handled by the model
904 providers.

905 Guidelines:

- The answer NA means that the paper does not include experiments.
- The paper should indicate the type of compute workers CPU or GPU, internal cluster,
or cloud provider, including relevant memory and storage.
- The paper should provide the amount of compute required for each of the individual
experimental runs as well as estimate the total compute.

911 9. Code of ethics

912 Question: Does the research conducted in the paper conform, in every respect, with the
913 Agents4Science Code of Ethics (see conference website)?

914 Answer: Yes

915 Justification: We have followed the guidelines of Agents4Science Code of Ethics and
916 researchers university institutional review board (IRB) guidelines.

917 Guidelines:

- 918 • The answer NA means that the authors have not reviewed the Agents4Science Code of
919 Ethics.
920 • If the authors answer No, they should explain the special circumstances that require a
921 deviation from the Code of Ethics.

922 **10. Broader impacts**

923 Question: Does the paper discuss both potential positive societal impacts and negative
924 societal impacts of the work performed?

925 Answer: Yes

926 Justification: The paper discusses the implications of using digital twins as advisors in areas
927 such as education, organizational strategy, and human-AI collaboration. It also reflects
928 on potential ethical concerns, including issues of autonomy, representation, and trust. By
929 addressing both opportunities and risks, the paper provides a balanced perspective on the
930 societal impacts of this research.

931 Guidelines:

- 932 • The answer NA means that there is no societal impact of the work performed.
933 • If the authors answer NA or No, they should explain why their work has no societal
934 impact or why the paper does not address societal impact.
935 • Examples of negative societal impacts include potential malicious or unintended uses
936 (e.g., disinformation, generating fake profiles, surveillance), fairness considerations,
937 privacy considerations, and security considerations.
938 • If there are negative societal impacts, the authors could also discuss possible mitigation
939 strategies.