

Creative and Effective Human Artificial Intelligence Co-Evolution-Interactive Front-End Content Generation

Vesa Salminen^{1,2}, Jyrki Peltomaa¹, and Juha Varis¹

¹Lappeenranta-Lahti University of Technology, LUT, Finland

²Häme University of Applied Sciences, Hämeenlinna, Finland

ABSTRACT

Artificial Intelligence, AI, as technology has been already a long time a great innovative opportunity to develop our functions and operations. Recently generative AI (e.g. Open AI, ChatGPT) has been in the focus. Artificial intelligence will change many things in working life and significantly increase the efficiency of knowledge work. The main assumption is that it does not in itself immediately replace humans. Instead, a human who skillfully utilizes artificial intelligence will replace a human who does not use artificial intelligence. This article introduces a study of combining Human Intelligence (HI) and Artificial Intelligence (AI) into successful outcomes. The main goal of this article is to discover a balance between AI and human intelligence interaction in novel solution generation. The article is constructed in a way to define human intelligence-related definitions (human intelligence, cognition, and cognitive skills). On the other hand, data is becoming an essential asset for AI, algorithms, and Machine Learning (ML). We consider the pitfalls, limitations, beliefs, and risks of AI. We try to solve an optimal and simultaneous use of working utilizing both AI and human intelligence into solutions for the future. Meaningful individual- and team-level psychological processes are in the focus in creative problem-solving solving, understanding complexity, ambiguity, and uncertainty. Social skills play an important role in synergistic communication in finding creative third alternatives which is new for everyone. Finally, we present a formula to organizational performance including IQ (individual intelligence) + CQ (collaborative and cultural) + EQ (emotional) + SQ (social intelligence) and generative AI combined with ML to be able to create an effective Human-Machine (HM) interaction.

Keywords: Human intelligence (HI), Artificial intelligence (AI), Machine learning (ML), Creativity, Human-artificial intelligence, Co-evolution, Social and cognitive skills, Collaboration

INTRODUCTION AND THEORETICAL CONSIDERATION

Artificial Intelligence, AI, as technology has been already a long time a great innovative opportunity to develop our functions and operations. Recently generative AI- opportunities, e.g. ChatGPT, have been pushed into the focus. It is important as an introduction and from the theoretical point of view to define human intelligence and artificial intelligence and analyze and understand the differences and opportunities of their interrelationship. That is essential to understand how to integrate AI into human-related processes successfully.

Human intelligence and artificial intelligence (AI) are distinct but interconnected concepts that revolve around cognitive abilities, problem-solving, learning, and adaptation. To analyze the relationship between human intelligence (HI) and artificial intelligence (AI) it is important to determine the terminology.

Despite a long history of research and debate, there is no exact standard definition of human intelligence. Human intelligence refers in this study to the mental capability that enables humans to learn from experience, feel emotions, make assumptions, adapt to different situations, innovate and make intuitions, justify reasoning, and solve problems. The overall explanation in this study is, that AI can be used in an assistive role to simulate cognitive functions such as learning, reasoning, problem-solving, perception, and language understanding.

Human intelligence (HI) is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience. It reflects a broader and deeper capability for comprehending our surroundings-“catching on,” “making sense” of things, or “figuring out” what to do (Gottfredson, 1997). Human intelligence is “the ability to comprehend; to understand and profit from experience” (WordNetSearch, 2024). Human intelligence can be an “ability to invent solutions to new problems” (creative intelligence), “to dissect problems into component parts, perform analysis” (analytic intelligence), and “developing a solution, and the ability to apply everyday knowledge and experience to develop solutions to problems” (practical intelligence) (Sternberg, 1985). In addition to previous definitions, ‘mental capabilities as a prerequisite to intelligence include human cognition such as perceiving, conceiving, remembering, reasoning, imagining, thinking, and problem-solving’ (APA Dictionary of Psychology, 2024). ‘Cognitive ability is defined as a general mental capability involving reasoning, planning, abstract thinking, complex problem comprehension, and learning from experience (Gottfredson, 1997). The mental capabilities stem from cognitive skills including attention, observation, awareness, reflection, questioning, perception, and comprehension.’

‘Artificial intelligence (AI) is explained in literature that it applies for advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take actions Advanced machine learning algorithms are composed of many technologies (such as deep learning, neural network, and natural language processing), used in unsupervised and supervised learning, that operate guided by lessons from existing information (Gartner, 2024/1)’. Machine learning algorithms is a subset of AI answering from clear parameters defined by people. ‘AI is best suited for handling repetitive data-driven tasks and collecting relevant data from big data. Human intelligence consists of the abilities to learn from experience, adapt to new situations, understand and handle abstract concepts, and use knowledge to manipulate one’s environment’ (Britannica 2023).

‘The human cognitive part must be framed together with intelligent artifacts requiring a systematic approach in the domain of joint cognitive systems. The emerging technologies in the Artificial Intelligence of Things are allowing

cyber-physical systems (CPS) focused on human-machine interaction to move from a physical interaction paradigm to a cognitive one' (Angulo et al., 2022). Chat-GPT performs worse than healthcare professionals in terms of clinical outcomes (Zaboli et al., 2024). The current level of Chat-GPT reliability is insufficient for it to serve as a viable substitute for triage nurse expertise in the context of patient prioritization within an emergency department setting. Humans and AI may not be able to configure and understand what the other entity is meaning to do or achieve, leading to miscommunications, errors, and mistrust (Memarian et al., 2024). Generative AI is a valuable assistant in the creative process and it is crucial in creative tasks when we fully understand this technology's potential benefits and drawbacks in shaping the future of creativity (Hope & Hanel., 2024). 'AI differs fundamentally from human intelligence, lacking essential qualities such as comprehension, self-awareness, emotions, embodiment, ethics, values, and culture' (Cao & Dede, 2023).

AI can support, augment, and automate human activities. ML involves learning from data which can be assisted with human interaction and fine-tuning – ML algorithms can help identify patterns for predicting outcomes. There are also some risks with AI: factual inaccuracies, understanding content, obsolete knowledge, copyright and IPR violations, and lack of originality leading to incorrect decision-making.

This article analyzes, how to combine human intelligence (HI) and artificial intelligence (AI) into successful outcomes. The main goal of this article is to discover a balance between AI and human intelligence interaction in novel solution generation.

RESEARCH QUESTIONS AND RESEARCH APPROACH

During this research has been analyzed the way of combining Human Intelligence (HI) and Artificial Intelligence (AI) into successful outcomes. The main goal of this article is to discover the balance between AI and human intelligence interaction in novel solution generation. The main research questions are:

- How could we in the best way utilize AI-assistive human-machine interaction?
- What are the pitfalls, limitations, risks, and even beliefs behind technology-related innovation?
- How could we harness AI-related technology opportunities as strategy-based innovation?
- What is the balance between human intelligence and artificial intelligence in novel solution generation?

The collection of data and research approach has been partially constructive, conceptual, and analytical because it introduce some suggestions of balance between artificial intelligence and human intelligence interaction. The article presents background experiences and results from various development initiatives and these works.

HUMAN-CENTERED ARTIFICIAL INTELLIGENCE

Human intelligence has been presented as practical, analytic, and creative intelligences (Sternberg, 1985). Practical intelligence (common sense) is an ability to find a fit between themselves and the demands of the environment (i.e. monitoring the environment). Analytical intelligence, also referred to as componential intelligence refers to an ability to analyze and evaluate problems (traditional measures of IQ tests). Analytical intelligence needs analytical and critical thinking examining problems from various perspectives. Creative intelligence is utilizing knowledge and skills to effectively handle new and unusual situations by using past experiences. Creative intelligence is the ability to go beyond what is given to create novel and interesting ideas. This type of intelligence involves imagination, innovation, and problem-solving (Sternberg, 1985).

In conclusion, integrating practical, analytical, and creative intelligences has a lot of potential to adapt and shape environmental change and evolution by creating novel solutions. Human intelligence is a summary of cognitive abilities and skills to be able to adapt to new circumstances.

Practical intelligence identifies and selects problems and collects relevant information whereas analytical intelligence leads to analysis (dividing the problem into separate parts) and diagnosis (reasons finding).

Creative intelligence has options to add creative features, elements, and functions during the different phases of the development process. Finally, collective interpretation and synthesis create a holistic and consistent view utilizing systems thinking in a creative synthesis generation. This kind of *synthesizing intelligence* is identifying and collecting relevant information, questioning disparate components from analyses, pulling elements together in a coherent way - integrating all elements into a holistic and novel solution. Synthesizing intelligence in this context means the capacity to collect relevant elements of value information flow, reflect on their meaningfulness, and organize by *interpretation and synthesis* into a holistic new structure and solution. Emotional intelligence means the capacity to be aware of, control, and express one's emotions, and handle interpersonal relationships.

Human intelligence has an essential social perspective – communication skills with others including an ecosystem of wisdom of crowds. Team intelligence surpasses individual intelligence – cohesive group members having the ability of open dialogue and interpretation deepen mutual understanding - social intelligence (SQ). Collaboration and collective acts create added value by utilizing team member's diversity, expertise, experiences, and tacit knowledge in a smart way of doing. This is a foundation to performance as depicted in Figure 2.

Leadership <i>Deliberate practices to collective act.</i> <i>Innovation guidance</i> <i>Smart way of doing.</i> <i>Shared tools, methods.</i> <i>Cohesive teams.</i> <i>Collective intelligence.</i> <i>Seeking inputs for shared comprehension.</i> <i>Learning what works.</i> <i>Dynamic capabilities development.</i> <i>Collective identity.</i>	Hypothesis formulation	Hypothesis testing	Hypothesis identification	
	Open dialogue, collective interpretation and synthesis			Reflection, perception and shared understanding - learning
	Collective thinking			Solution options search - alternatives
	Data processing - analysis - diagnosis			Useful information, essential questions, problems framing and definitions
	Value information flow			
	Concentration on attention, observation, empathic listening, and questioning			Alertness and curiosity to business environment, emergence of change

Figure 1: Cognitive skills into novel solution – from data acquisition to hypothesis formulation.

HUMAN INTELLIGENCE AUGMENTING AND ASSISTING ARTIFICIAL INTELLIGENCE

How can we profit from combining human intelligence and judgments assisted and augmented by AI? What can possibly go wrong? How to control AI activities? With the fast development of AI, it may be apparent that automated processes can assist human involvement in automated data collection, Data Mining (DM), and useful content creation in – strategic data-driven innovation where data mining needs to extract and identify new patterns. Various algorithms and techniques: classification, clustering, and AI with neural networks are used to discover information, patterns, trends, or knowledge from large datasets. Through data gathering and screening, processing, and decision-making, AI can support faster solutions to complex problems. ‘Decisions must often be made under obvious uncertainties with incomplete and uncertain knowledge’ (Chowdhury and Sadek, 2012). Decisions can face also complexity and ambiguity which need hybrid intelligence. AI depends solely on data, algorithms, and special instructions to generate results whereas humans have cognitive abilities – multiple creative thinking styles (associative, creative vs. critical, divergent, reasoning from different perspectives etc.), imagination, insights generation, and intuition which support AI. It is obvious, that artificial intelligence cannot completely replace human intelligence.

Artificial intelligence can boost our analytic and decision-making abilities by providing the right information at the right time – by harvesting and providing employees with tailored data, and information from different sources. ‘AI can help the reach better decisions (Argawal et al., 2018) – enhancing creativity.’ AI tools extracting large datasets open possibility to find even unknowns, to develop learning capabilities and make additional foundation for creativity – offering broad input space for analysis and synthesis cycles. AI tools reduce time spent on data analytics by access to large datasets of digital information and knowledge. New relevant data creates additional questions for novel alternatives specific questions to specific answers. Integrated HI and AI leverage strengths from each other. AI promotes better exploitation of R&D results and scientific articles collection. AI is best suited for handling repetitive data-driven tasks and collecting from big data the relevant data. Human intelligence exploits external ecosystems, experts, and partners.

Table 1. Major differences between human intelligence and AI in creating novel solution, knowledge, concepts, and solving problems.

	AI	Human Intelligence
Data, information, and knowledge (DIK)	DIK collection, productivity in data, and information collection.	New DIK creation, value information flow creation.
Data-analytics	Automation in design, deployment, and management of data delivery.	Analysis, diagnosis, interpretation, and synthesis chain in understanding uncertainty, complexity, and ambiguity.
Data-driven actions	Repetitive data-driven tasks and supporting decision making, lack of transparency.	Value information flow.
Problem solving	Supporting information search for analysis.	Identification and framing problems, creative and complex problem-solving.
Knowledge	Background knowledge (available).	New knowledge creation. Tacit knowledge based on experiences as possibility to original solutions. Knowledge from experiences.
Concept development	Information of available concepts.	Abstract concepts understanding and creation.
Creativity	Available novel solution search, augmentative.	Novel solution creation, Innovative thinking and reasoning skills: creative vs. critical, divergent vs. convergent, imagination, associative thinking, abductive reasoning, and abstractive thinking.
Business environment evolution	Past evolution factors.	Adapting to new situations, events, or problems. Manipulating environment.
Foresight	Past and current information, path-dependence.	Processing unknowns, creation new future opportunities. Trend spotting.
R&D	Exploitation R&D, scientific articles.	Innovation eco-system partner, contacts to universities, partners, consults, building new and original theories.
Intelligence	Artificial.	IQ, EQ, SQ, and CQ (cultural and collective), and communication, collective interpretation with others.

HI AND GENERATIVE AI CO-EVOLUTION-INTERACTIVE LEARNING AND DEVELOPMENT

‘This kind of hybrid collaborative intelligence is defined as the ability to achieve complex goals by combining human and artificial intelligence, thereby reaching superior results to which each of them could have accomplished separately’ (Dellerman et al., 2019). Hybrid intelligence means continuous learning from each other and evolving together – reciprocal interactive collaboration and co-evolution. HI and generative AI complementing each other optimize and maximize exploitation HM-intelligence performance potential. Integration of human intelligence (practical, analytical, creative, and synthesizing) intelligence with AI and machine learning (ML) can bring many benefits, such as harvesting data from multiple sources, storing, and transforming – automated and intelligent systems start to help companies automate certain tasks, identify value for better outcomes. Generative AI and ML map intelligently data from large datasets by automated data collection (Automated ETL), restructuring unstructured data, and DM for analysis. These concepts combined create additional value for actual BI (Business Intelligence) concepts – benefitting hybrid intelligence. Exploiting human creative intelligence, tacit knowledge, experiences, expertise, and synergistic communication gives a possibility to third alternatives which are new and novel for all – unique novel solutions. The final BI system has a creative element to get novel solutions. The best optimal solution can be generated by the HI, AI, and BI interaction – optimized, collaborative, and hybrid intelligence.

Generative AI opens up transformation in data analytics and BI. Data is becoming an essential asset for AI algorithms and machine learning – a fuel of AI enabling data-driven organizations into knowledge-centric. The optimizing process stems from connecting human-centric strengths and generative AI – a mix of suitable intelligences for different purposes for an intelligent enterprise – *a new BI paradigm with AI-based ICT architecture (Figure 2).*

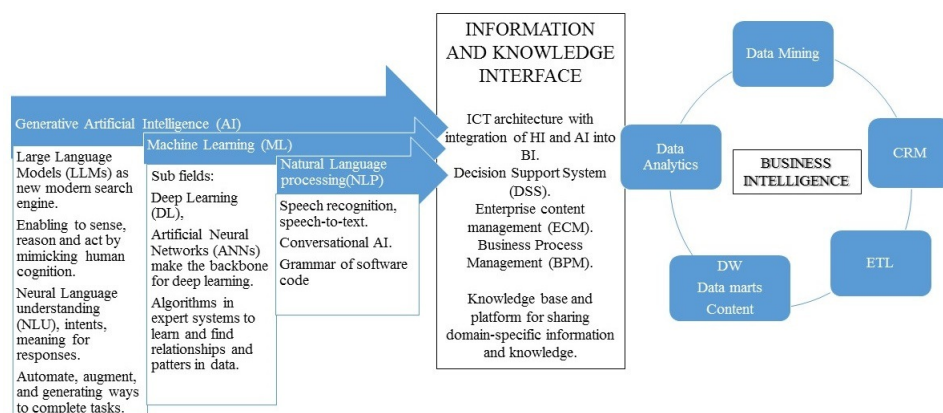


Figure 2: ICT-architecture combining BI (business intelligence) and AI intelligences. Machine learning is a different approach to create software – learning from training data to be able to automate tasks.

This architecture augments the traditional infrastructure of collecting and processing (DM), storing (DW), analyzing data (data analytics), and managing customer relationships (CRM) – *an intelligent enterprise content management system*. The challenge is to integrate HI and AI-based software into a useful mix of firm-specific decision-supporting systems. Future opens up multitasking with connected AI-based software of LLMs (Large Language Models), ANNs (Artificial Neural Networks), Language Models for Dialogue Applications, and deep learning algorithms in understanding and generating new concepts for new business models. Even the next steps of automated MLs (AutoML) are presented for experimenting with automated training data generation for training ML. This is a major step forward leading into data processing and preparation (gathering, combining, structuring, and organizing data).

Human assistance is needed so that AI-based systems function with responsible, reliable, proper, and safe way – machines do not understand biases that training data may reveal. Is the future of generative AI-based systems automatically collecting internet content as a background for training data, problem-solving, and decision-making?

CONCLUSION

In this article are analysed differences between human and artificial intelligence. It is also introduced the way of combining them and understand the differences and opportunities to create successful outcomes. The main goal is to discover the balance between human intelligence and artificial intelligence when creating interaction in novel solution generation.

For future direction on the use of technological opportunities, finding the balance between HI-AI and focusing development, Gartner has defined the concept of “Artificial Intelligence for IT operations, AIOps”. ‘It refers to the strategic use of AI, machine learning and machine reasoning technologies to automate processes of IT operations, including event correlation, anomaly detection, and causality determination’ (Gartner, 2024/2).

It is essential to develop data-driven processes in which human-centric strengths, assistive generative AI, and AI-based multivariable analysis can be integrated to form an intelligent enterprise.

REFERENCES

- Angulo, C., Chacón, A., Ponsa, P. (2022) Towards a cognitive assistant supporting human operators in the Artificial Intelligence of Things. *Science Direct, Internet of Things* 21 (2023) 100673. Journal homepage: www.elsevier.com/locate/iot, <https://doi.org/10.1016/j.iot.2022.100673>.
- Agrawal, A., Gans, J., Goldfarb, A. (2018) A Simple Tool to Start Making Decisions with the Help of AI. *Harvard Business Review*, April 17, 2018.
- APA Dictionary of Psychology, <https://dictionary.apa.org> (read 11.2.2024).
- Britannica (2024). https://sv.wikipedia.org/wiki/Encyclopedia_Britannica (read 11.02.2024)

- Cao, L., & Dede, C. (2023) *Navigating A World of Generative AI: Suggestions for Educators*. The Next Level Lab at Harvard Graduate School of Education. President and Fellows of Harvard College: Cambridge, MA.
- Chowdhury, M., Sadek, A. W. (2012) "Advantages and limitations of artificial intelligence". *Artificial Intelligence Applications to Critical Transportation Issues*, 6, Transportation Research Circular E-C168.
- Dellermann, D., Ebel, P., Söllner, M., & Leimeister, J. M. (2019) Hybrid intelligence. *Business & Information Systems Engineering*, 61, 637–643.
- Gartner (2024/1) AI Dictionary (2024) What is Artificial Intelligence <https://www.gartner.com/en/topics/artificial-intelligence> (read 11.02.2024).
- Gartner, (2024/2) Artificial intelligence for IT operations AIOps. <https://www.gartner.com/en/information-technology/glossary/aiops-artificial-intelligence-operations>. <https://doi.org/10.48550/arXiv.2304.04661>.
- Gottfredson, L. S. (1997) Mainstream science on intelligence: An editorial with 52 signatories, history, and bibliography. *Intelligence*, 24(1): 13–23.
- Leslie, A. (2024) AI Ethics and Governance in Practice: AI Fairness in Practice. Alan Turing Institute. <https://www.turing.ac.uk/research/research-projects/ai-ethics-and-governance-practice> (read 11.02.2024).
- Memarian, B., Doleck, T. (2024) Human-in-the-loop in artificial intelligence in education: A review and entity-relationship (ER) analysis. *Computers in Human Behavior: Artificial Humans, CHBAH 100053*. <https://doi.org/10.1016/j.chbah.2024.100053>
- Sternberg, R. J. (1985) Beyond IQ, A Triarchic Theory of Human Intelligence. CUP Archive. <https://www.oxfordlearnersdictionaries.com/definition/english/emotional-intelligence> (read 11.02.2024).
- WordNetSearch. Princeton University. <https://wordnet.princeton.edu> (read 11.02.2024).
- Zaboli, A., Brigo, F., Sibilio, S., Mian, M., Turcato, G. (2024) Human intelligence versus artificial intelligence: Who performs better in correctly classifying patients in triage? *American Journal of Emergency Medicine, YAJEM 161988*. <https://doi.org/10.1016/j.ajem.2024.02.008>