E-CARGO/RBC: Enabling Interdisciplinary Innovations in the Era of AI

Haibin Zhu, Nipissing University, Canada

In the age of Artificial Intelligence (AI), a wide range of AI tools, including Large Language Models (LLMs) [1], can assist with many lower-level tasks such as routine problem-solving, office working, and coding. These tools have the potential to automate numerous low-skill jobs [2]. To adapt to this shift, workers must focus on mastering advanced modeling tools to tackle emerging challenges. E-CARGO/RBC (Environments - Classes, Agents, Roles, Groups, and Objects / Role-Based Collaboration) [3] is a powerful modeling methodology designed to address complex problems systematically, moving beyond reliance on basic programming skills.

AI's goal is to emulate human intelligence, which is grounded in a deep understanding of the world. Achieving this understanding requires tools, and one of the most critical tools is modeling. Modeling enables us to navigate and interpret the complexities of the world, a process that inherently involves consciousness. Consciousness is built on abstraction, and abstraction is effectively facilitated by the E-CARGO model. Thus, to unlock AI's full potential, humans should leverage the E-CARGO framework (Fig. 1) to guide and manage AI tools effectively.

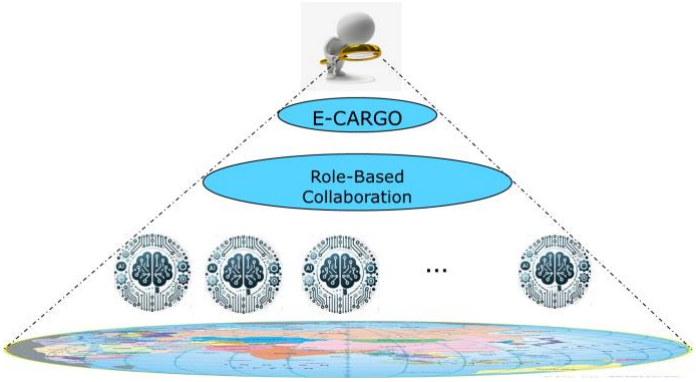

Fig. 1 Solving the Real-World Problems using E-CARGO and AI tools.

RBC [3, 4] is a computational methodology that uses roles as the primary underlying mechanism to facilitate collaboration activities. It consists of a set of concepts, principles, models, processes, and algorithms. RBC and its E-CARGO model have been developed to a powerful tool for investigating collaboration and complex systems. Related research has brought and will bring exciting improvements to the development, evaluation, and management of systems including collaboration, services, clouds, productions, and administration systems. RBC and E-CARGO grow gradually into a strong fundamental methodology and model for exploring solutions to problems of complex systems including Collective Intelligence, Sensor Networking, Scheduling, Smart Cities, Internet of Things, Cyber-Physical Systems, and Social Simulation Systems.

E-CARGO [3, 4] assists scientists and engineers in formalizing abstract problems, which originally are taken as complex problems, and then proposes solutions to such problems including optimizations. The E-CARGO model possesses all the preferred properties of a computational model. It has been verified by formalizing and solving significant problems in collaboration and complex systems, e.g., Group Role Assignment (GRA) [5]. With the help of E-CARGO, the methodology of RBC can be applied to solve various real-world problems. E-CARGO itself can be extended to formalize abstract problems as

innovative investigations in research. On the other hand, the details of E-CARGO components are still open for renovations in specific fields to make the model pertinently applied. For example, in programming, we need to specify the primitive elements for each component of E-CARGO. When these primitive elements are well-specified, a new type of modelling/programming language can be developed and applied to solve general problems with software design and implementations.

Since the first paper on RBC was published [6], over twenty years have passed, and E-CARGO/RBC has been developed into an integrated and systematic methodology and model [3, 7] (Fig. 2) for researchers and practitioners to model and solve complex problems in the modern world. It provides a set of symbols, concepts, models, algorithms, and specifications.

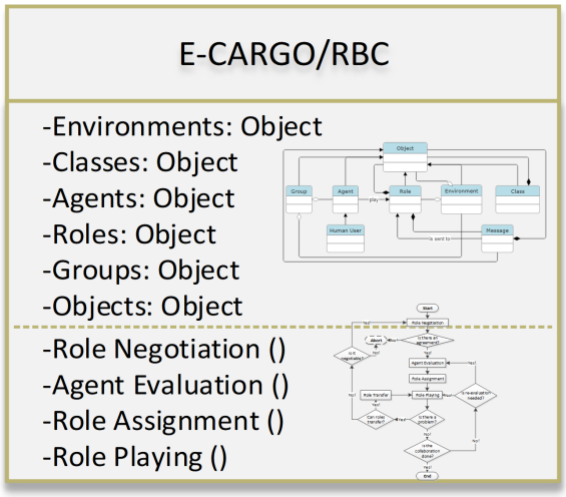

Fig. 2. E-CARGO/RBC is an integrated model and methodology.

E-CARGO contributes to modelling, e.g., GRA and its related problem models, i.e., GRA with Constraints (GRA+) [8-12] and GRA+ with Multi-Objectives (GRA++) [13, 14] are inspired by delving into the details of the E-CARGO components and the RBC process. GRA can help solve related collaboration problems with the help of programming and optimization platforms. All the related Java codes can be downloaded by GitHub: https://github.com/haibinnipissing/E-CARGO-Codes. We welcome interested researchers and practitioners to use these codes in their research and practice and contact the author if there are any questions about them.

Thanks to the highly abstract level of E-CARGO/RBC, it possesses grand potential in various applications, especially in the disciplinary fields of SMCS. For example, social simulations using E-CARGO/RBC [15-20] can exploit its abstraction ability and representability. It fills the gap between traditional micro-level simulations using agent models and macro-level simulations using mathematical formulations. Hybrid human and robot team establishment [21] is a promising field for E-CARGO/RBC development by improving human-in-the-loop, i.e., a human and a machine execute the tasks alternately, to human-on-the-loop, i.e., a human manages that the machine executes the tasks, and finally human-over-the-loop, i.e., a human manage that many humans and machines collaboratively execute the tasks. E-CARGO/RBC can also be applied to many cutting-edge topics, such as cloud computing [7, 22], service computing [7, 22], crowdsourcing [23], task allocations [11, 24], refugee resettlement [16], Learning teams [25], and Model-Based Systems Engineering [26].

In the era of AI, E-CARGO/RBC presents unlimited opportunities for early career researchers to extend their research to solve brand new problems discovered in the real world through using E-CARGO/RBC across different areas, such as evolutionary computing for solving combinatorial optimizations [27], categorization algorithms for role negotiation [28], agent collection or agent formulations [17, 27], dynamic agent models for role playing [29], and multi-criteria decision making, artificial intelligence and machine learning methodologies for role negotiation and agent evaluation [30].

A prototype of role dictionary (e-cargo.info) is under construction to form a crowdsourcing platform for people to establish role networks and conduct social network analysis from an abstract level. We welcome researchers and practitioners to access, add their preferred roles and comment on the prototype by joining our E-CARGO community (e-cargo.ca).

SMCS is the sole home of E-CARGO/RBC. With the support of the SMCS, we have successfully organized two summer schools on E-CARGO and Applications [31, 32] (Fig. 3). We plan to organize the 3rd one in 2025 and at the same time, we plan to organize the 1st International Symposium on E-CARGO and Applications (e-cargoschool.com). We welcome more and more SMCS members to join us and make more contributions to our SMC society.

Fig. 3 Photos taken from the first two E-CARGO and Applications Summer Schools.

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