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# Are We Intentionally Limiting Urban Planning and Intelligence? A Causal Evaluative Review and Methodical Redirection for Intelligence Systems

**MOHAMED A. HAWAS**
Urban Design and Community Development Section, Department of Architecture, Faculty of Engineering, Cairo University, Giza 12613, Egypt
e-mail: m_hawas@live.com

**ABSTRACT** The chronic growth of networked complexities in today's world, now require highly efficient evolvable systems. However, diverse open issues and inabilities are facing urban planning practice and social sciences due to the limitations of artificial intelligence planning tools. These incapacities have relatively limited our ability to perceive and handle possible present and future temperamental situations in socio-physical contexts and in real-time modes. Here, we theoretically present two simple philosophical and systematic causal models to help software engineers to understand this philosophical and complexity dilemma from an urban planning perspective. The first model evaluates the reliance on perceptual and bounding trajectories. It discusses discrete and finite-expert systems that perceive specific parts of self-organization's complexities, while bounding limited facets only of general intelligence to address certain issues in urban planning and social contexts. This implies the second causal model that is based on aligning to urban self-organizational happenings, by putting philosophical foundations for a responsive artificial superintelligence (ASI). This proposed ASI is based on connecting between complex adaptive systems in our contexts by open-endedly hosting and operating infinite expert systems to reflect different fields and functions, toward asymptotic infinite intellectual capacity.

**INDEX TERMS** Philosophical considerations, artificial intelligence, artificial superintelligence, urban planning, complexity theory, causal evaluation, expert systems.

## I. INTRODUCTION

In the last 30 years, artificial intelligence (AI) practice has shown perpetual advances [1, p. 25] in all dimensions, which is part of a larger causally driven direction of development, to reflect higher understanding of systems' complexities. Here in this theoretical study, a philosophical redirection is suggested in computer science practice based on systematically illustrating two simple causal models. The first, aims to evaluate and explain how current AI approaches are limiting urban planning and design processes, and this, chronically, limits our ability to effectively perceive and approach infinite facets of urban environments' complex adaptive systems (CAS). The second causal model, pushes a concept of a theoretical artificial superintelligence (ASI)-ready system. The model debates that intelligent applications in urban planning and design should no longer depend on their specific and finite field's knowledge-base, but rather on asymptotic comprehensive real-time knowledge. In view of this, the model causally proposes open-ended utilization and self-organization of infinite number of hosted intellects and approaches. This is argued here to allow AI to address different complex aspects of existing and resulting contextual environment. In other words, we aim here at a philosophical thinking that would allow a collective culture of intelligence with endless sets of functions that are not limited to design and urban planning knowledge-bases only, but they greatly support their objectives. Relevantly, artificial intelligence in general is categorized in three lines: a) Artificial Narrow Intelligence ANI that describes a limited intellectual and specialized AI that cannot perform all tasks as a human brain [1, pp. 1020–1024], as Expert Systems (ES). b) Artificial General Intelligence AGI that describes an AI that is as general and intelligent as a human brain, [2, p. 260], which is not achievable yet. c) Artificial Superintelligence ASI that describes an AI that has more intelligence than all brains in every field, collectively [3, p. 11]. Nick Bostrom describes four ways a superintelligence-based AI system – when achieved – could function, as in: a) oracle: a question answering system, b) genie: a command execution system, c) sovereign: a system that is activated in the world to initiate a search for broad and/or long term objectives, d) tool: to create an AI that acts like as software, and as a tool, rather than an agent [4, pp. 145–151]. Generally, Experts' opinions suggest that we would reach AGI by 2040 and ASI by 2075. However, Ray Kurzweil foresees AGI by 2029 and ASI by 2045 [5, p. 10], [6, p. 10].

The article includes four parts: 1) illustrating various AI-based approaches and urban development tools, and causally modelling their limitations and how they reflect ANI. 2) Discussing international endeavors for possible transition from ANI. 3) Philosophical causal realization of a basic ASI-ready system as a planning tool, 4) A theoretical assessment for the responsiveness of this proposed philosophy, if further applied.

## II. MODEL ONE: CAUSAL EVALUATION OF EXPERT SYSTEMS

Two trajectories are being criticized here: 1) Perceptual – task-oriented AI tools/expert systems, and 2) Bounding – usage of specific AI approaches. First trajectory reflects that in urban planning and socio-economic fields, the functions and AI engines of current AI tools are limited to, and specialized in, one or more fields and tasks. This implies specific types of users. Too, this results in an ANI that is relatively limited to perceiving and dealing with certain variables of self-organization's CAS and persistently ignoring other CAS in urban systems that are not recognized nor processed for being different than what the expert system is programmed to process and output. Accordingly, this implies an influence over specific and temporally nonextensive contextual catalysts that are part of finite urban and socio-physical CAS, and influencing users into making expert systems to serve specific fields and functions. In that sense, a tool that responds to specific systems, cannot fully respond to all self-organizational processes that are generated by a world that uses general intelligence (human brain) to self-organize. This connects to the bounding trajectory, as such tools are based on a narrow scope of intelligence, while open-ended development requires degrees of freedom to allow an extensive and unbounded inclusion of intellects. Consequently, this causes further frontier inabilities by imposing preceding limitations on expected results via the usage of specific AI approaches, which constrains urban planning studies and analysis. This explains why we should aim at an open-ended platform that is capable of hosting endless intellectual cores, to reflect the oracle, the genie, the sovereign, and the tool. Current development and analysis tools in urban planning field are argued here to be called as expert systems, as shown in Table 1. These expert systems and tools reflect both trajectories, for instance, artificial neural networks or evolutionary AI as genetic algorithms, are only a weak ANI if they are following the limitations implied by both trajectories.

The causal model in Figure 1 illustrates the sequence of which perceptual and bounding trajectories are implying ANI. This is followed by ANI's causal relations in Table 2.

**TABLE 1. Various AI approaches and models in urban planning.**

| Year | Bounding trajectory (specific AI) | Perceptual trajectory (specific task) |
|---|---|---|
| 2016 | Analytic Hierarchy Process (AHP)-fuzzy rule based systems | Assessing urban land-use suitability, [49, p. 385] |
| 2016 | Fuzzy logic and analytic network process/(ANP) | Assessing land suitability for urban development, [51, p. 1] |
| 2016 | Back-propagation neural network (BPNN)-(GIS) | Assessing suitability for agricultural, [52, p. 1] |
| 2016 | Multi agent System/MAS | Simulation of urban policies, [53, p. 216] |
| 2016 | Cellular automata/CA | Urban growth, [48, p. 47] |
| 2016 | Decision support systems, Knowledge-based (KB) | Counteracting urban heat islands, [54, p. 109] |
| 2016 | Genetic algorithm/GA | Pollution study, [47, p. 345] |
| 2015 | MAS | Urban growth, [50, p. 9] |
| 2015 | ABM | Population's spatiotemporal impact on urban context, [44] |
| 2015 | Memetic algorithm-GA | transit network optimization, [56, p. 3760] |
| 2015 | ABM | Simulating community/land use/transport relations, [44] |
| 2013/15 | ABM | Determining location of creative land uses, [44] |
| 2014 | Fuzzy DEMATEL, ANP, VIKOR | Planning city's logistics, [57] |
| 2014 | ABM-AHP | Urban growth, [55] |
| 2014 | (LUTI)/TRANUS | Urban growth, [50, p. 9] |
| 2013 | ABM–GA–CA | Spatial change through population relations, [44] |
| 2012 | Artificial neural networks/ANN | Urban growth, [50, p. 9] |
| 2012 | Fuzzy logic- ANN | Spatial housing allocation, [15, p. 360] |
| 2011 | ABM | Simulating spatial movement towards nodes, [46, p. 370] |
| 2008 | AB-CA | Sustainable development, [43, p. 255] |
| 2008 | CA | Landscape pattern recognition, [44] |
| 2008/7/5 | Fuzzy logic-CA-GA, -CA, CA-ANN | Urban growth, [43, p. 257] |
| 2007 | Fuzzy neural tree | Simulating performance, [15, p. 355] |
| 2003 | CA-ANN-Fuzzy logic | Land use evaluation, [43, p. 257] |
| 1999 | KB-ANN–Fuzzy logic | Decision making via scenarios, [45, p. 257] |

In a more detailed explanation, as there exists an expert system implying ANI, conditioned by a sole field that implies finite functions and intellects related to the field, this implies finite general intellectual capacity that is proportional to the field's finite CAS. This accordingly doesn't imply strong connections to the whole spectrum of self-organization CAS, nor an influence over infinite contextual catalysts see Eq. 1.

$$\exists \left\{ ES \Longrightarrow ANI \mid F \Longrightarrow f, I_{finite} \right\} \Longrightarrow \left( (IC_F < IC_\infty) \propto CAS_{field} \right) C_\infty \tag{1}$$

(Where $ES$ is expert systems, $F$ is sole field, $f, I_{finite}$ is functions and intellects related to a sole field, $IC_F$ is intellectual capacity related to a certain field, $IC_\infty$ is infinite intellectual capacity, $CAS_{field}$ is a one specific finite CAS in self-organization's wholeness context that has been influenced by the field related to the finite intellectual capacity, and $C_\infty$ is infinite and extensive contextual catalysts).

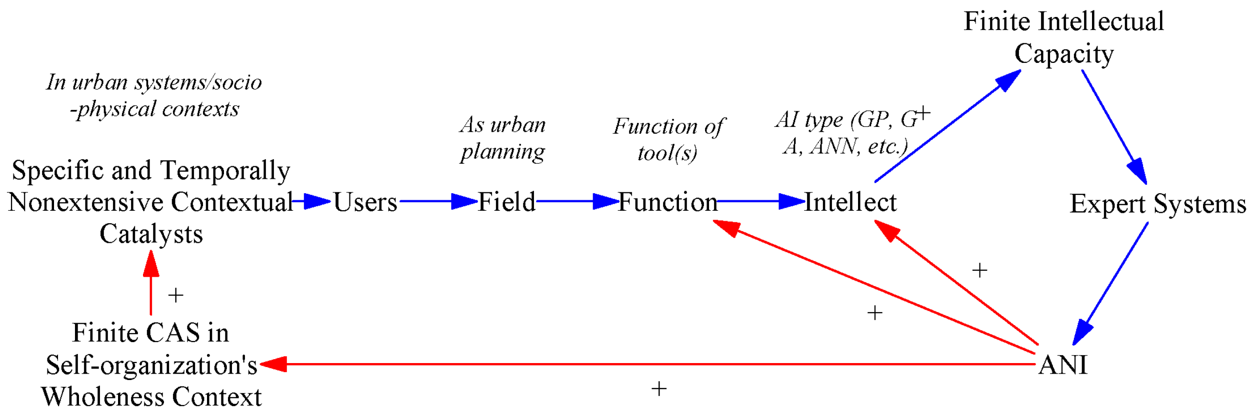


**FIGURE 1.** **Perceptual and bounding causal trajectories.**

**TABLE 2.** **Causal relations of ANI trajectory. source: researcher.**

| Event | Relation | Tree |
|---|---|---|
| Intellect | Causes | Expert Systems — ANI<br>(ANI), Field → Function<br>ANI, Function → Intellect |
| | Uses | Intellect — Finite Intellectual Capacity — Expert Systems |
| ANI | Causes | Finite Intellectual Capacity — Expert Systems — ANI |
| | Uses | ANI — Finite CAS in Self-organization's Wholeness Context — Specific and Temporally Nonextensive Contextual Cata<br>ANI — Function — (Intellect)<br>ANI — Intellect — Finite Intellectual Capacity |
| CAS | Causes | Expert Systems — ANI — Finite CAS in Self-organization's Wholeness Context |
| | Uses | Finite CAS in Self-organization's Wholeness Context — Specific and Temporally Nonextensive Contextual Catalysts — Users |

## III. INTERNATIONAL INCAPACITIES: TRANSITION FROM ANI

Various studies focus on interpreting reality by understanding self-organization in urban planning processes [7, p. 241], [8, p. 253], in order to understand and deal with urban complexities as part of harmonizing between different urban and social systems [9, pp. 43, 51,and 52], [10, p. 153], [11, pp. 2988 and 2989]. These efforts are incomplete by perceiving self-organization as an object in urban systems [12, pp. 951 and 953], or by describing it as composed of various components [13, pp. 654 and 655], rather than being understood as a structuring process in systems, as Kauffman implicates [13, pp. 654 and 655]. This results in overlooking energy synergies that are responsible for the connected existence of systems' internals and externals [14, p. 235]. Consistently, such self-organization is not only based on our measurements of the present [15, pp. 214 and 215] as being our main concern, but also on the past, and the future, that constitute reality based on contributions that have led us to a certain status of evolution. This negatively influences the way AI is internally built to interact with all contextual systems, which results into developing expert systems. In that sense, and in order to align with all self-organizing socio-physical CAS, we should be making a transition that requires developing open-ended evolving system of general intelligence to deal beyond the specifics. However, as we currently depend on specifics by using limited sources of knowledge [16, p. 167], that is also based on parameterization [17, p. 35], [9, p. 43], this philosophically constrains such transition from ANI to AGI towards ASI in general and in urban planning. In view of this, the approach of volunteer-based evolutionary algorithms, focuses on efficiency and computational power to harmonize between different algorithms. [18]. This relates to the transition by achieving emergence processes [19] of collective intelligence by effectively operating various algorithms to reach open-endedness.

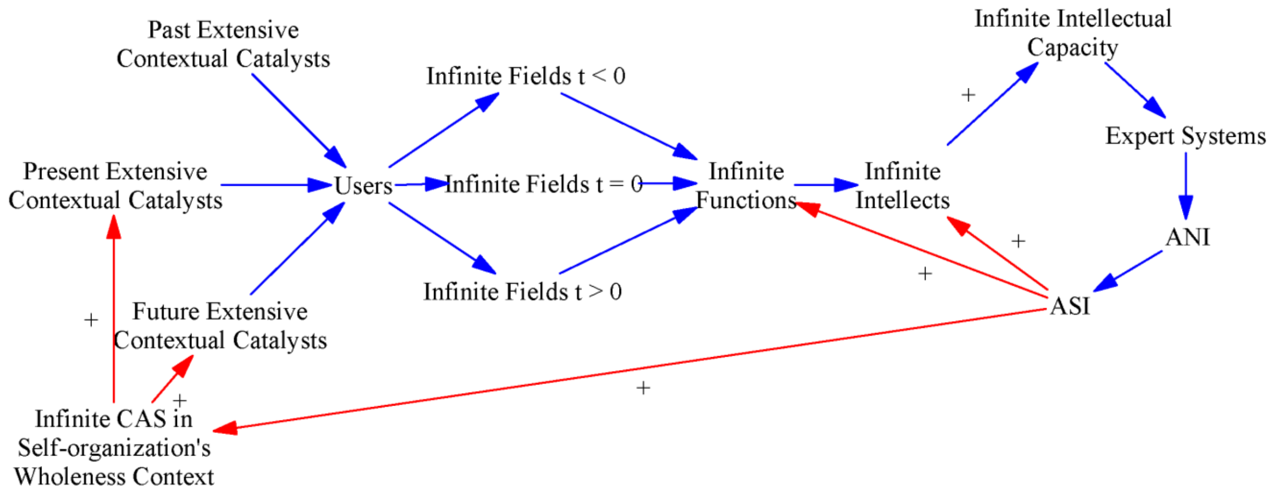


**FIGURE 2.** **Proposed ASI-ready causal trajectory.**

Relevantly, Stuart Kauffman argued that to really achieve this and to understand reality, it becomes essential to skip Turing machines [20, p. 137], [21], and to develop a Trans-Turing System TTS that is non-algorithmic, non-deterministic, non-random [22, p. 187], in a poised realm [23, p. 235]. Kauffman presents two responsive approaches to achieve TTS. The first approach implies simulating a TTS behavior on a computer, e.g., through genetic algorithms GA [22, p. 188], while the second approach implies creating self-reproducing molecules systems by using autocatalytic sets of polymers charged by pyrophosphate that enables open-ended evolution [22, p. 188]. However, to choose and employ a specific intellect as GA, or, chemical and biological reactions to serve as an open-ended platform, is to limit the way to reach open-ended evolution [24, p. 380]. On the other hand, it is not realistic to practice systemic generalization [25, p. 406] by putting limitations on AGI / ASI systems' particulars as a result of not recognizing the same characteristics we are using to constitute the world, as determinism, randomness, algorithms. Moreover, as we are in introspection and complexly self-organizing as part of the world [26, p. 388] in a critical poised realm that is also related to order, chaos, and based on our measurements [27, pp. 1 and 9], then we cannot simply expect a system that negates or ignores or sets aside these aspects would fully succeed in achieving general intelligence.

## IV. MODEL TWO: CAUSAL REALIZATION OF ASI-READY PLATFORM

The second causal model illustrates how it could be possible to achieve an open-ended platform of urban planning through an adaptation to change phenomenon. This generally requires a new philosophy of programming, to correspond to the constant changeability of self-organization. In order to approach this, and to create a responsive ASI, we should develop an open-ended space of mediation with enough freedom to allow its elements to change and to evolve according to changes occurring in self-organizing socio-physical and natural contexts. The causal model suggests a hypothetical open-ended platform as a hosting phase space to connect between different and infinite AI applications and source codes (algorithmic and possibly non-algorithmic as TTS, when achieved) together, in a compounding manner, that are deployed and operated by the platform's potential users, including the AI means to connect between deployed AI applications in certain ways [18]. The main purpose of the model is to causally visualize why connecting between different timeframes, fields, functions, intellects, could result in a collective evolution of infinite AI applications, in order to correspond to, track and understand all CAS in self-organization processes in socio-physical contexts, without preceded (past) or initial (present) or impending (future) restrictions. In Figure 2, we explain how wholeness expressed in infinite CAS in our self-organizing world, is directly influenced by an infinitely enabled intellectual capacity driven by an infinitely enabled inclusion policy for infinite fields in a triadic timeframe, where past, present, and future contributions shape the system. These causal relations of the ASI trajectory, are illustrated in Table 3.

In that sense, as there exists expert systems implying ANI that is conditioned by infinite functions and intellects if and only if infinite fields are being considered on a full temporal spectrum; this collectively, forces a general intellectual capacity that is asymptotic to infinity, see Eq. 2.

$$\exists \left\{ ES \Longrightarrow ANI \mid \left( f, I_\infty \Longleftrightarrow F_\infty \wedge t = \left\{ \begin{array}{l} t < 0 \\ t = 0 \\ t > 0 \end{array} \right. \right) \right\} \Vdash (IC \approx IC_\infty) \tag{2}$$

(Where $F_\infty$ is infinite fields, $t$ is time of the interaction, $f, I_\infty$ is functions and intellects related to infinite fields).

Relevantly, there exists an ANI system implying an ASI system if and only if intellectual capacity is asymptotic

**TABLE 3.** Causal Relations of ASI Trajectory.

| Event | Relation | Tree |
| --- | --- | --- |
| Intellect | Causes | ANI — ASI — Infinite Intellects<br>(ASI), Infinite Fields t < 0, Infinite Fields t = 0, Infinite Fields t > 0 — Infinite Functions — Infinite Intellects |
| | Uses | Infinite Intellects — Infinite Intellectual Capacity — Expert Systems |
| ASI | Causes | Expert Systems — ANI — ASI |
| | Uses | ASI — Infinite CAS in Self-organization's Wholeness Context — Future Extensive Contextual Catalysts / Present Extensive Contextual Catalysts<br>ASI — Infinite Functions — (Infinite Intellects)<br>ASI — Infinite Intellects — Infinite Intellectual Capacity |
| CAS | Causes | ANI — ASI — Infinite CAS in Self-organization's Wholeness Context |
| | Uses | Infinite CAS in Self-organization's Wholeness Context — Future Extensive Contextual Catalysts — Users<br>Infinite CAS in Self-organization's Wholeness Context — Present Extensive Contextual Catalysts — (Users) |

to infinity, this generally approaches the limit of, and corresponds to infinite CAS in self-organization's wholeness context that is being in superposition with infinite and extensive contextual catalysts see Eq. 3.

$$\exists\,((ANI \Longrightarrow ASI) \Longleftrightarrow (IC \approx IC_\infty)) \doteq |CAS_\infty\rangle + |C_\infty\rangle \quad (3)$$

(Where $CAS_\infty$ is infinite CAS in self-organization's wholeness context).

## V. THEORETICAL ASSESSMENT OF THE CAUSAL MODEL: THE GUIDELINES

The following assessment depends on discussing how this hypothetical causal model responds to current urban issues and the incapacities to evolve current AI into ASI as part of the efforts to face these complex urban challenges. Relevantly, the continuous growth of information and complexities in urban systems [28, p. 29], [29, p. 44], makes it unavoidable to develop responsive planning tools. In that sense, it becomes essential to understand these interconnected sophistications of systems [30, p. 123] and knowledge [31, p. 207] in urban contexts [32, p. 1177], through the dependence on general knowledge rather than finite specifics and models of generalization [16, p. 167], [33, pp. 28 and 29], [34, p. 153], as in expert systems. These sophisticated urban systems generally show different networked cycles of information [29, p. 44], and interactions of systems' radially evolving energy [35, p. 43] that cannot be separated on study level nor reality level. In order to model these networked systems in a realm of uncertainty [36, pp. 65 and 66], we have to generically and generally understand systems' extents without being limited by specific field, by modelling and tracking the flow of information through space and time as infinite generic compounding units, of energy [37, pp. 232, 236, and 237] rather than parameterization [9, p. 43], [17, p. 35]. In other words, this model offers a possible approach that enables us to shift our mindset to start considering, responding to, and intervening in all CAS, beyond expert systems' bounding and perceptual approaches, since we can be able to think of different CAS as causally interconnected by cyclic energy waving [29, p. 44], [35, p. 43]. The purpose of such shift, exceeds the direct benefits of AGI or ASI, as it could be possible to track, model and understand the whole spectrum of systems' complex processes of self-organization [38, p. 202], [39, p. 26], [40, p. 10] and the origins of life [41, p. 348], based on reading causal interconnections [42, p. 388].

## VI. CONCLUSION

The proposed ASI causal model generally reflects an initial philosophical framework that is based on interchangeable characteristics of general knowledge, for further development of open-ended evolving AI systems. This sets basis to model and mathematize the perceivable global self-organization's processes and resulted contextual transformations in urban and socio-physical contexts, which would possibly allow further discovery or understanding of yet unperceivable complex systems. However, current AI practice is philosophically limited to ESs' incapacities, in terms of their sole structural capabilities to exhibit general intelligence. The model there-for reflects that we should philosophically revisit strict technical thinking in evolutionary computing and AI science, in parallel to what we are aiming at in other fields as urban planning here.

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**MOHAMED A. HAWAS** was born in 1984. He received the B.S. degree in urban planning from the Faculty of Urban & Regional Planning, Cairo University, Egypt, in 2007, and the M.Sc. degree in urban design & community development from the Faculty of Engineering, Cairo university, in 2013, about the transformations of psychological energy as a cognitive tool for urban path networks, where he is currently pursuing the Ph.D. degree in urban design & community development with the Faculty of Engineering. His Ph.D. thesis concerns modeling self-organization processes in socio-physical systems and developing a novel philosophy for an advanced artificial intelligence system to operate this model.

His current research interests include urban planning and artificial intelligence dualism, complexity, self-organization, and systems science.

Mr. Hawas is an Egyptian Urban Designer who has been a member of the Egyptian Syndicate of Engineers since 2007, and the International Society of City and Regional Planners since 2014. He has been also a member of The U.S. Green Building Council as a LEED AP-ND, since 2014.