Architecture as a Digital Diagram

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This paper results from interdisciplinary research about dynamic and transformational processes of conception, representation and spatial construction in Architecture. This work systematizes the common bases of the diagram offered by disciplines that deal with processes of representation, such as Cognitive Science, Logical Semiotics, Mathematical Logic and Philosophy, and of spatial investigation such as Topology and Architecture. It outlines operative components (trans, inter and intra-diagrams) and the diagram’s phenomenological variables (thought, space, time) and establishes mutual relationships between it, digital media and Architecture, with the intent of developing the understanding of the digital diagram as an enhanced way of placing information in time and space.
1. Introduction

The work of the architect, in its wide range of actions, has, as core activity the handling of space, spatial structure that corresponds to a social dynamic, which in turn is defined by phenomenological relations between man and space in three co-dependent instances: design, production and praxis. It is something with which one reciprocally acts and, through this action, understanding and enjoyment are constructed. The design is the first step, the key and an element that gives the architect basis for action on any material (or immaterial) reality. As a propositional action, it transforms given conditions, it is the synthetic answer to analysed situations and questions. As an intentional action, it has the temporal dimension of a present action that reflects (in) a future, the future designed in the present, an action that anticipates, that foresees. As an action, it inserts the designed object in all its real dimension, besides consciously endowing it with attributes that distinguish it as a production of knowledge and, as such, an object of seeking, pondering, classification, enjoyment. These are acts of creation, processes of thought and instituting action of conformed relationships through imaginative instants that are associated to design. Mental associations that draw nearer to the intent, not as an acknowledgement of what was foreseen, but as a dynamic development of “beings” until they reach a stable relationship (that is not motionless but structured). It is a process that demands visual, mental and/or physical interfaces as a support for presentation and or spatial representation, be it as a virtual instance of concrete spaces, or as an actual instance of virtual spaces. According to Lévy:

“...it is the virtual that exists in potentiality and not in action. The virtual tends to bring itself up to date, without having a past when it comes to taking shape, effectively or formally (...) Actualisation is creation, invention of a form out of a dynamic configuration of forces and finalities (...) The virtualisation is not an unmaking of reality (the transformation of a reality into a set of possibilities), but a mutation of identity, a replacing of the subject’s gravitational centre, instead of mainly defining itself from his update (a ‘solution’), the identity finds its essential consistency in a problematic field. To virtualise any identity consists in discovering a general question to which it is related, in making the entity mutate towards this question mark and in redefining the actualisation of the starting point as an answer to a particular question.”[1]

The production of space as a continuous action of transformation of imagination, a virtual construction in actual construction, creates the base for the praxis of space that does not depend of its material reality. The praxis of space is formed by actions of interpretaton, of signification, of perception and of use through which the space is effectively constructed to
(and inside) the man who inhabits and usufructs it. Design, production and praxis are sown together through movements of virtualisation and update that build the existential chain of the architectural “being”. Starting from the updating of the space of experience, the architectural “being”, virtualised in design, is actualised in its process of production. As a product of this process, it presents itself as a virtual base for countless of social uses that, in their turn, actualise it as the space of experience at every instant. This, in its turn, as a repertoire, becomes a virtual instrument for new spatial configurations that are yet to be designed.

2. Architecture and information technology

The mention of the transformation that has been developing itself in the last decades in the core of societies due to its immersion in the so-called Era of Information has become a common place. As to Architecture, since the first impacts of the introduction of CAD systems (Computer Aided Design), that goes back to the 1970s, much has also been investigated and explored, seeking to accompany the very development of Information Technology, or yet, in some cases, to demand its advance.

One can perceive the enormous advance that occurred in the last decades of the development of graphic environments for geometric and algebraic modelling of solids and surfaces, of interactive environments for simulation and communication, and of means of physical and virtual construction of prototypes; a fact that, besides requiring reviews about design procedures historically used, demands reconsideration of the limits of the subject “Architecture”. And, out of these new limits, the research of virtual and interactive environments, of interfaces between the physical and virtual environments that make use of these new technologies, appears all well as an answer to the growing virtualisation of the human relations, propitiated by this very technological development – mainly of the means of communication from afar.

Taking into consideration the enhancement and development of the new communication technologies in the urban territory, one thick virtual layer can be added to it. This virtual layer interconnects millions of people in multiple places and put them together in only one same place, instantly creating circuits of conversation, service networks, information webs and sessions of co-presence, which, in some aspects, mirror the real urban territories and concentrate themselves in the so-called virtual urbanization – faster and more fluid than the real one. According to Santos, “the territory is commanded from the capacity of information and the information streams are the ones which structure space... The spatial circuits of production create movement of matter and the circuits of co-operation create streams of information that are the new space constructors.”[2]
It is important to notice that Architecture, as a field of application of technology, has always been, in one way or another, reflecting the most general technological advances, such as, for example, the ones historically mentioned by the Industrial Revolutions [3]. In this direction, one can perceive nowadays the transformations brought by the Digital-Information Revolution [4], but which, differently from previous revolutions, entered Architecture not through production, but initially through design and presently constitutes a sphere in which design, as well as production and praxis of space are immersed.

As an example, Table 1 shows four periods in the development of technology, that in Architecture are not linear and coexist in the present days, binding them to means of design and means of production of concrete Architectures [2].

<table>
<thead>
<tr>
<th>Technological revolutions</th>
<th>Design-Production Conditions</th>
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<tbody>
<tr>
<td>Pre-Industrial Revolution</td>
<td>Non-existence of Design – Manual Design / Production of Crafts in corporations</td>
</tr>
<tr>
<td>First Industrial Revolution</td>
<td>Manual Design / Pre-Fabrication of components and assembling in work fields / New materials: iron and glass</td>
</tr>
<tr>
<td>Digital-Information Revolution</td>
<td>Digital-Information design: CAD-CAE, modelling, prototypes etc. / Production integrated with design / Quantity, variability, originality / New materials: synthetic and intelligent materials</td>
</tr>
</tbody>
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As a field of culture and in correspondence to the question of its contemporary time, Architecture occupies a new place in the growing territory of information streams. On the amplification of its scope, two structural modifications that were instigated by Digital-Information Revolution are crucial codification of Architecture as information and assimilation of time along with the spatial matrix that historically constitutes the discipline’s specificity. And it is in this context that the amplification of understanding of diagram’s concept in architectural field gains expressiveness, because, as it will be shown further in this work, it makes itself up as a mean of spatialization of information (thought, desire) in time. And that, in the end, establishes a strict relation between Architecture and digital media: information, space, time.

3. Diagram – an interdisciplinary construction of its concept

It is well-known that the possibilities of interaction person-person and person-object-environment made possible by digital means, that amalgamate
action and visualisation in dynamic processes of interaction, have been operationally and conceptually supporting the notion of process, or yet, of meta-process (assimilation of the process’ development) in the architectural design’s requirements. Simultaneously and frequently in a related way, a growing assault of architects on fields of knowledge that do not belong to the architectural subject has been developing; fields that extend from Philosophy to the Hard and Biological Sciences. This process seeks the broadening of horizons in the investigations on processes of conception and transformation. Such context – of digital immersion and disciplinary extension – has been pointing the diagram as paradigm of process, a concept that, for some time, has been developed in subjects that deal with representation and with mathematical spatial investigation.

When Whitehead [5] constructed his philosophy of process, he presented the concepts of substance and process as the world’s basic metaphysical categories and introduced the idea of “actual occasion” as a “process of becoming”, as opposed to an “enduring substance”. From this concept he considered that the objects are not simple spatial placements, but fields that have spatial and temporal extensions, as a series of events and processes in direct relationship with a substance. According to Chandrasekaran, Glasgow and Narayanan [6], in Cognitive Science, the concept of diagram receives two distinct, yet correlated, interpretations that frequently participate together of a process of representation: the diagram as a mental and internal representation and as an external representation in an environment. And other researches of this field have focused in some functions of the diagram, when it finds itself in cognitive activities, that we relate with the process of design in Architecture as memory, imagination, perception, locomotion or sense of orientation, inference and solution of problems [7,8].

Peirce’s Semiotic [9] refers to the idea of the process of representation, thought as well as representation in an external environment, as organised processes in triadic movement between sign-object-interpreter. And, according to the interaction sign-object, one sees Peirce’s primordial classification of signs: icon, index and symbol, gradient pertaining to signs of representation since the pure quality or possibility to simple convention or acquired knowledge. The diagram then distinguishes itself by being a system of flexible representation, a fact that results of diagrammatic sign’s multiple characters, that is, of its triadic condition, which is the relation that it maintains with the sign’s three levels of classification presented by Peirce [9]. That condition relates to its main constitution by an iconic aspect present in the similarity of connections between its parts and the connections existing between the parts of the object, from which it was constructed and from which it became a way of creation. Two other aspects can be associated to the first: one, indicial, translated in the brands of the object’s parts that where assimilated, which gives him the characteristic of
this object's indicant mean. The other, symbolic, appears in the rules about what was constructed, giving it an aspect of a way of communication.

There is, then, in the diagram, according to Peirce [9], the entanglement between representation and creation, because, through its drawing and observation, new relationships between elements that did not seem to have a necessary connection before can be synthesised. This entanglement is recovered by Jay Zeman [10] that brings out the semiotical aspect that intrinsically belongs to the diagram's meta-process, because, as it is an icon, it represents through resemblance and provides a map (representation) of the process it investigates (creation).

The formulation of the concept of the diagram in contemporary Philosophy by Deleuze [11], with broad dissemination in contemporary architectural vanguards, feeds itself of the character of pure quality or the iconical sign's mere possibility, and subverts it. To Deleuze the diagram would be an abstract machine, an emergence from another world, a fact's possibility, not the fact itself. From this point of view, the diagram as something yet to be is previous to any object and because of that does not represent it, but sets itself as its possibility:

“So defined by its diagrammatic aspect, an abstract machine is not an infrastructure in as a last resort, neither is it a transcending Idea in supreme instance. Before that it has a leading role. This happens because an abstract or diagrammatic machine does not work to represent, even something real, but constructs something real that is yet to be, a new kind of reality. It is not, therefore, out of history, but always 'before' history, at every moment in which it constitutes points of creation or potentiality.” [12]

In Mathematical Philosophy, Russell [13] approximates sequential languages and diagrams as for its relational character, however differentiating them in their shapes. The first ones only make use of concatenation relationships through a complex and compensatory syntax, the second ones, fundamentally use spatial relationships, direct and intuitive, for the representation-creation of the object’s spatial relationships.

In Mathematical Logic, Costa [14] associates the diagram to the intuition’s performance in construction of logical reasoning. For the Logic, the phenomena are captured by sensible intuition and processed by intellectual intuition, which provide a visualisation endowed with certain evidence of experiences or of objects with which one works. That allows acquisition of immediate knowledge, referring to objects and relationships. Still debating about the same course, March [15] and Boaventura [16] refer to the graph, a sort of diagram, in a similar way, outlining it as a mean that allows, respectively, global perception of topological aspects and revelation of a set of relationship’s essential structure.

According to Sampaio [17], in Geometric Topology, a field of
Mathematics that deals with spatial invariants under continuous transformations, with investigation of spatial properties like continuity and discontinuity, sees the diagram as a mean through which specific operations (homeomorphism, identification and connected sum) are executed in surfaces. By means of its fundamentally operational character, the processual topological diagram accomplishes representation of spatial structural relationships, which is, the surface’s topology, a surface in transformation in time according to the topologist intentions.

The processual topological diagram makes itself known by representing “frame by frame” the modelling of a surface, be it from identification and homeomorphism and starting from a plain polygonal area, or from the connected sum and homeomorphism of basic closed surfaces. It does not centre the representation, isolated, on the initial or on the ending surface, but on the process of which they are integral parts as origin and as stage in which certain desired relationships were structured. Just as it possesses a propositional character that advances from the initial surface to the final configuration, it posses a prospective character, that reconstructs possible paths and operations executed for surface’s modelling. A surface becomes attached to the diagram like the product is to the process (Figure 1).

3.1. Diagram’s phenomenological variables

Starting from interdisciplinary similarities, we suggest the concept of diagram’s systematization according to three primordial operative components that are associated to three phenomenological variables. In the processual diagram there are relationships components, trans, intro and inter-diagrams, that reveal themselves by integrally constructing the process’ mapping. Each external diagram establishes a relationship with a thought’s or desire’s internal diagram and vice-versa (trans-diagram), a relationship...
between object-inference-representation through structural similarities. It constructs its internal relationships, inherent to the elements of which it is composed (intra-diagram), that promote a direct visibility of the relationships in operation, corresponding to the object’s present relationships. And, finally, participates of a logical movement of connection that represents process’ sequence (inter-diagram) [18].

Or, in another way, when one associates Whitehead’s [5], Peirce’s [9], Zeman’s [10], Deleuze’s [11,12], Russell’s [13], Costa’s [14], March’s [15] and Boaventura’s [16] references to the components present in the processual diagram (trans, intra, inter), these begin to determine their three phenomenological variables. The trans-diagram refers to thought or desire, to the being’s (as something yet to be) multiple possibilities of constitution, its mental and physical representations (Peirce [9], Deleuze [11, 12], Costa [14], March [15], Boaventura [16]). The intra-diagram refers to space, to the spatial elements that are a part of the diagram and to the existing relationships between them (Russell [13], March [15], Boaventura [16]). The inter-diagram refers to time, inherent to the space construction process to what it concerns (Whitehead [5], Costa [14], Zeman [10]).

And, more specifically, the processual topological diagram can be considered a mean of perception and investigation, of creation and representation of topological relationships (space) subject to the figure’s processual transformation (time), that happens simultaneously to the mental conceptual process (thought and desire) in a two-way flux. They are thought and spatial relationships guided in time by relations of similarity – structural nearness between elements – and not by relations of contiguity – conventional approximation between elements.

Process and diagram superimpose themselves, just like it occurs with the process and its result. When the diagram includes thought/desire, space and time to itself, it is simultaneously the very process and, in potentiality, the created element – originated from a given spatial relationship that is conceived in the process. The created element is product or the last diagram of a processual sequence, as well as another’s diagram, as well as a diagram of another, which, in its potentiality, is the continuity.

4. Diagram in architecture – spacial X shape information

The allusion to the diagram in Architecture is not unique to contemporary time. The diagram centred at the process of creation’s geometric origin – that establishes relations of proportions between parts of the object – can go back to Leonardo da Vinci’s De Divina Proportione (1509) or closer to Le Corbusier’s Modulor (1942–48).

The progressive use of the diagrams is, however, synchronous to the development of the theory of communication and semiotic and to the first computational meaningful developments in the 1950s and 1960s.
Christopher Alexander’s patterns (Figure 2), the typological-geometric diagrams of operational recurrence, Rudolf Wittkower’s typological-geometric diagrams of formal recurrence about Palladio (Figure 2) and Colin Rowe’s about Le Corbusier-Palladio data from this period.

In Contemporary Architecture, whether has it a basis in some of the subjects and courses already covered on this essay or not (and normally associated to the use of digital modeling), the process of design through diagrams has been distinguished in the works of paradigmatic architects such as Rem Koolhaas, Peter Eisenman (Figure 3), Greg Lynn (Figure 3), Ben van Berkel, Lars Spuybroek, MVRDV, FOA, among others.

When it is a common denominator between these architects’ positions (where one can more approximately see distinct shades of differences) the concept of diagram is shaped as a mean of creation, operation and representation of formal transformations/spatial relationships that assimilate the act of processing. That matches allocation of the exploration’s meaningful part in the area of a geometric diagram centered at the origin to a diagram centered at the process.

Still on the matter of processual diagrams, it is possible to differentiate geometric processes that investigate and represent the formal
transformations during the design’s process from the topological processes that investigate and represent spatial relationship, placing the Architecture’s formal aspect under its spatial aspect, thus modifying the basis of spatial conception and of the design’s action that speculates on the form so that space can be handled. That would, for example, match an initial opposition between Peter Eisenman’s and Greg Lynn’s formal operations and Lars Spuybroek’s, Ben van Berkel’s, MVRDV’s and Rem Koolhaas’ organizational relationships (Figure 4), even when these, in some cases, end up translating themselves into formalisms.

The interest in the topological processual diagram for Architecture lies on the fact that it, in itself, binds the processes of thought to the spatial dispositions. When it is assigned by the terms of space, structure and relation, an area of intersection sets itself up between the two areas: Topology and Architecture. A topology understood as structural spatial relations, that is, as relations that structure space, and an architecture understood as relational spatial structures, in other words, as related portions of space and with a relational calling. A situation in which a topology would be composed of an architecture and an architecture would be structured by a topology. According to Mimram,

“One of the goals of topology is that of representing the fundamental rudiments that lie on the basis of geometric restrictions, that rule the structures, that of showing the set of relations that bind them, and how they can be mutually transformed. If we assign a structure of a configuration, the set of relations between the entities of this configuration, then the topology relates to the structure of the
structures."[19]

For the same author, topology, besides referring to spatial connections, is etymologically associated to the matching mental processes:

“The topology is the spatial structure’s most global way of approximation, the most pertinent. If we consider Architecture as the spatial disposition’s matching science, then we go back to the topology’s etymological term. In its origin, this geometry was considered a mnemonic procedure, in which the line of thought comprehends many alternatives, during a contemplative promenade, it was assimilated in the bifurcations of the covered senses. Such a connection between a geometry of position and an intellectual process is fundamental in our structural thought’s evolution.”[19]

Through its iconic-analogical-relational (Peirce [9]), analogical-synthetic and spatial-relational (Russell [13]) aspects, that reveal the topological relations (March [15] and Boaventura [16]) and processual investigation (Zeman [10] and Costa [14]), the processual topological diagram makes up an analogous topology when it represents or investigates a topology (be it in its spatial constitution – when it places the elements that are in relation – or in its temporal dynamics – when it accompanies the topological operations in process). As a topology, the very diagram is “a mnemonic procedure, in which the line of thought comprehends many alternatives”, it is an interface between space and time,"a connection between a position and an intellectual process". Mimram [19] strengthens in an undeniable way the confluence of three variables in the topological processual diagram: thought, space and processual time, approximating them by the notion of Topology, of Architecture, “match science of spatial dispositions”.

If the present idea of diagram in Contemporary Architecture provides the placement of time and movement (space in time) as variables of a designing process, the consideration about the processual topological diagram’s complete insertion replaces the two variables, time and movement, to the possibility of investigation of architectural space in its whole, in which the shape is just one of its data and does not end it.

5. Diagram, digital media, architecture

Information, space and time are the matrix out of which the three subjects (diagram, digital media and Architecture) can bind themselves and feed each other on the contemporary world. Differently from the trinomial drawing-computer-Architecture that was structured on a causative linear shape, the set diagram-digital media-Architecture establishes a whole that is much more imbricated and dynamic, named digital di(archi)grams: Architecture as a digital diagram, in which the architects-inhabitant’s information about processes of interaction with space (design-production-praxis) is virtualized and actualized in this very space, as long as the interaction goes on. By
digital media, diagrams and Architectures tend to become one and the same substance, digital di(archi)grams, cognitive-communicative environments [20] that spatialize information in a period of time.

Such overlapping is felt by Architecture as well as by Technology of Information. In the last years the investigation about architectural space’s sensibility of the events that take place in it has been growing [21], generating a space that updates itself at every moment, as a result of this information’s iteration. The architect-inhabitant does not become the one who conclude the work, because it always changes, but he becomes the one that accomplishes the work by movement (space-time) after it is materialized in space as occurs, for example, in the freshH2O eXPO (Netherlands, 1997) of the architect Lars Spuybroek, or in the Blur Building (Switzerland, 2002), of the architects Elizabeth Diller and Ricardo Scofidio. Architecture would no longer be a basis in order to fuse to the media that dynamically alter the space; the limit between movement in space and movement of the space. Zellner remarks this, quoting Spuybroek’s opinion:

“Some might argue that because architecture is ultimately static, it cannot incorporate or embody kinematics, animation or any other form of movement or transformative energy. But Lars Spuybroek would respond that ‘Media are a way to inhabit time... a movement connected with our own movements... we should keep in mind that architecture was the first machine, the first medium to connect behaviour and action to time...’” [22]

The reciprocity relationships between figure/space and information, container and content, geometry and algebra, hardware and software are notably structured on digital media (and even feed the metaphors in the field of Architecture), suggest through the diagram’s concept the very imbrication between them and Architecture, but in more consistently way. In the presence of the dichotomy software-hardware, process-product or digital media-Architecture, one thinks on its fusion as spatial media, composed of spatial information that structure new spatial information [23].

When the imbrication between diagram and Architecture (Architecture as a mean to bring information in time into space, executed through the digital media) establishes relations of continuity between design, production and praxis of space, it requests for the Technology of Information the very advance of the media as cognitive-communicative environments [20].

Nowadays, the relations between Architecture and digital media are still fragmented inside the instances of design, production and praxis and, at best, associate two of them — design-production, design-praxis — intermittently and during a controlled time period, and so on. However, one perceives a direction towards continuity between design, production and praxis of space, CAD/CAE’s tools approximate design and production, the means of three-dimensional simulation approximate design and praxis and
the means of immersible modeling approximating production and praxis. As exemplified by the paradigmatic cases of figure’s dynamic prospecting, by Greg Lynn or Peter Eisenman, of structural investigation and production by Frank Gehry, of organizational dynamics by Ben van Berkel or of interaction between inhabitant and space by Lars Spuybroek, among many others.

To this use’s stage of digital media in Architecture, still diachronic and fragmented, corresponds the assembling line’s analogy of an industrial process made of subsequent actions executed by specialized people. The digital di(archi)gram assumes that the digital media’s advance is that of cognitive-communicative environments, to make possible a synchronic and continuous communication between the architect-inhabitant and his interface; besides a global access to the process, that is parallel as an analogy, not to the craftsman, centered at the productive craftsmanship, but to the very designer, centered at the designing process, in which one understands design, production and praxis as actions of spatial design.

As speculation, we imagine the digital di(archi)gram’s phenomenological instances, out of which we delineate to the diagram. The first instance, digital transdiagram, relates to the transfer of information between data banks (thought, desire, programs) and space. As an interface, substituting CAD (Computer Aided Design) systems, a digital media system, DAD (Digital Architectural Design), would accomplish the communication between the architect-inhabitant’s neural net – the locus of thinking – and the space. As a cognitive-communicative environment, the Touch Screen would give its place to the ThinkSpace, a spatial interface of the thinking process locus. The second component, digital interdiagram, is related to the design process’ (design-production-praxis) organization and temporal memory, allowing feedback and immediate returns to any stage of the process. Undo/Redo and Timeline, understood as temporal paradigms in digital media that have linear progression as presupposition, would give their place to a MemoryNet, like a map of a rhizomatic design [12]. The third component, digital
intradiagram, relates to the independent spatial information: topological, topographical, environmental, formal, material and structural of each diagram. As paradigm that brings information to space, the Model Tree, of an arborescent structure, would give its place to the SpaceRizome, formed by rhizomatic and retro-feeding connections [12] (Figure 6).

The commonly accepted division between what is named concrete Architecture and virtual Architecture looses its sense since, to an Architecture, multiple, concrete and virtual Architectures will be related: one of them would be a diagram updated in concrete space through the architect-inhabitant’s interaction and many others, virtual diagrams are potentially, at this same time, the becoming.

6. Conclusions

When accomplishing the connection between an information process and a spatial structuralization through its operative components (trans, inter, intradiagrams) and its phenomenological variables (thought, space, time), the diagram becomes paradigmatic to the pondering about the process of design (as a whole made up by design, production and praxis) of space in Contemporary Architecture. When the diagram’s matrix of variables (made up by information, space and time) represents, similarly, the digital media’s
and Architecture’s nodal matrix, binds the diagram in an intrinsic way to the variable’s functioning of the first ones and the appropriation of the space investigated by the second one. And through its common synthesis, as cognitive-communicative environments [20] to spatialize information in a period of time, diagrams and Architectures through the digital media, trail a path to become one and the same substance: digital di(archi)grams. Finally, the architectural space, simultaneously concrete and virtual, is composed of a current diagram and many other virtual diagrams yet to be actualized by information resulting from the interaction man-environment in time.

Acknowledgements
To Professor Ton Marar, from the Institute of Mathematical Sciences and Computation (ICMC), University of Sao Paulo, Brazil, for his priceless contribution as the supervisor of this research work.
To Professor Azael R. Camargo, from the Department of Architecture And Urbanism, Engineering School of Sao Carlos, University of Sao Paulo, Brazil, for his constant availability for a swapping of ideas.
To Professor José Cabral Filho, from the School of Architecture, Federal University of Minas Gerais, Brazil, for his comments and first appreciations of the research that originated this paper.

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